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# SCIENCE

DECEMBER 25, 1953

VOLUME 118

NUMBER 3078

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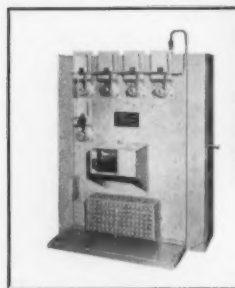
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## Society of General Physiologists

*New Affiliate of the American Association for the Advancement of Science*

THE Society of General Physiologists was founded in the summer of 1946 at the Marine Biological Laboratory, Woods Hole, Massachusetts, under the leadership of Robert Chambers, E. N. Harvey, L. V. Heilbrunn, and M. H. Jacobs. For some years there had been a growing need for more communication between biologists interested primarily in fundamental physiological principles rather than in applications, and in phenomena common to all organisms rather than those limited to special groups. The degree to which the proposed society met this need is indicated by the fact that more than half of the hundred charter members attended on short notice the founding meeting and first program of scientific papers in September, 1946.

From the very start the Society has ignored the artificial boundary between plant and animal physiology. From the organizational viewpoint the working of this policy is seen in the mixed membership of botanists and zoologists and in the list of past presidents of the Society: L. V. Heilbrunn, D. R. Goddard, H. F. Blum, K. V. Thimann, J. H. Bodine, L. R. Blinks, and H. B. Steinbach. From the scientific viewpoint the policy has paid off richly in interesting meeting programs, often disclosing unsuspected links between diverse disciplines. Illustrative of such presentations are the one- or two-day symposia sponsored annually, among which (with organizers) have been "Biological Oxidations" (Barron), "Biological Effects of Light" (Wald), "Electrolytes and Tissue Function" (Fenn), "Cell Function in Relation to Cell Structure" (Mazia, reported in *SCIENCE*, 114, 683 [1951]), "Contributions of Comparative Physiology to General Physiology" (Giese), and this year's colloquium on "Photoperiodism" (Hendricks), described in some detail in this issue of *SCIENCE*. A measure of the deliberately informal workings of the Society is the frequent presence of nonmembers on such programs. Besides the symposia, one or more additional

days of the annual meeting are devoted to short contributed papers, abstracts of which have often been published in the *Biological Bulletin*.

The Society has usually met at Woods Hole in June or September, finding the relaxed atmosphere there peculiarly congenial, and the physical arrangements and off-season accommodations both convenient and well suited to its modest financial resources (annual dues are two dollars). However, meetings are held elsewhere whenever feasible (for example, with the A.I.B.S. at Ithaca in 1952), and a real effort is made to stimulate local interchange of physiological ideas by regional meetings, such as those held in Philadelphia, New York, Bethesda, Pacific Grove, and St. Louis.

The management of the Society is vested in a council consisting of the three officers and four additional members, all elected. The 1953-54 incumbents are: president, A. K. Parpart (Princeton); vice-president, F. A. Brown, Jr. (Northwestern); secretary-treasurer, J. B. Buck (National Institutes of Health); council members, D. E. S. Brown (Michigan), L. R. Blinks (Stanford), D. R. Griffin (Harvard), and W. D. McElroy (Johns Hopkins). Our A.I.B.S. representative is W. R. Duryee (National Cancer Institute), and our representatives on the AAAS Council are H. B. Steinbach (Minnesota) and L. R. Blinks.

Membership in the Society is attained by election, after nomination by two members, and approval by the council. Qualifications are broad, aside from the requirement of a substantial record of published basic research in general physiology, and the composition of the present roster of about 250 testifies to the underlying unity of interest among biochemists, cytologists, biophysicists, microbial, cell, and comparative physiologists, and other brands of "General Physiologist."

JOHN BUCK

*Society of General Physiologists*

*SCIENCE*, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 26, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948. All correspondence should be sent to *SCIENCE*, 1515 Massachusetts Ave., N.W., Washington 5, D. C. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. Four weeks' notice

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# High-Frequency Scatter Sounding Experiments at the National Bureau of Standards

Richard Silberstein

- National Bureau of Standards, Washington, D. C.

**R**ADIO BACKSCATTER EXPERIMENTS employing four basic types of presentation were made. The original radar-type intensity vs time recordings were followed by range-time recordings, which revealed great variability from day to day in the structure of the line showing the apparent skip-distance change for the operating frequency as time progressed. The plan-position indicator revealed many irregular phenomena and demonstrated difficulties of record interpretation. The use of the sweep-frequency technique for obtaining backscatter records out to long distances represents a new approach and effectively demonstrates that the reliability of the technique of determining skip distance by means of backscatter on a single frequency may sometimes be very poor.

It has been known for many years that when a pulsed radio transmitter operating above the critical frequency of the F2 ionosphere layer is connected to a directive antenna it is possible to receive distant echoes back from the direction of maximum gain. Most of these echoes have been shown to be propagated from distant ground regions via the various layers of the ionosphere, notably the F2 layer, as if a radar transmitter with very poor resolution were receiving echoes back from distant large areas of the earth, not directly, but by means of an ionosphere layer as a reflecting mirror. Thus it appeared that observations of the range of these echoes would be useful in determining radio-sky-wave skip distance in the direction from which they are received.

The early belief that the distant scatter source was the top of the E layer (1) has been largely discounted by various observers in recent years. However, use of a new technique of scatter sounding recently developed at the National Bureau of Standards indicates that the role played by scatter from the top of the distant E layer may be more important than has recently been thought. This technique, evolved after a series of backscatter experiments which began in 1946, is *sweep-frequency scatter sounding*.

Four different methods of studying backscatter echoes have been used at the National Bureau of Standards since 1946.

## INTENSITY VS RANGE PHOTOGRAPHS AT A FIXED FREQUENCY

The original backscatter experiments at the National Bureau of Standards (2) used equipment employing A-plan or A-scope types of cathode-ray tube



FIG. 1. Typical A-plan record of backscatter from regions to west of Sterling. Range to scattering region is shown for the instant of photographing. Transmitted pulse occurs at jog in broken rectangle at left; received echo is at right about 15 milliseconds later as shown by abscissas scale graduated in half-millisecond markers. Height of echo gives relative amplitude.

display as did early radar equipment.<sup>1</sup> Photographs of the display were made at intervals of about 15 minutes. Each such picture showed delay time and amplitude of the various echoes for a single operating frequency at a particular time of day, obtained by beam- ing the transmitting and receiving antennas in a particular direction. Figure 1 shows such a photograph. Delay time for the echo (i.e., time for a pulse of energy to leave the transmitter and return) is obtained by referring to 0.5-millisecond markers which appear along the bottom of the time base. The time of the transmitter pulse is shown by the break in the pedestal<sup>2</sup> at the left-hand end of the sweep. The scatter

<sup>1</sup> In the A-plan display the beam is made to sweep across the cathode-ray tube face in a straight line at a rapid repetitive rate in synchronism with the transmitted pulse. This pulse, known colloquially as the "main bang," is displayed as a jog in the sweep, as are the echoes. If the transmitted pulse appears at the extreme left of the sweep, the echoes will appear to the right at a distance along the sweep corresponding to the time it takes for a radio wave to reach the echoing area and return. In a simple case, if the pulse rate were 100 per second it would take 10 milliseconds (1/100 second) for the sweep to cross the tube face. Since an echo travels a given distance and returns over the same distance at a rate equal to the velocity of light the maximum range to the echoing area is determined as one half of 300 kilometers per millisecond (the velocity of light) times 10 milliseconds or 1500 kilometers. The sweep in Fig. 1 represents a 50 per second sweep rate and takes 20 milliseconds to cross the tube face. For special reasons this sweep was designed to operate at twice the pulse rate of 25 per second.

<sup>2</sup> In the type of Ioran navigating instrument adapted to this experiment the sweep is broken by a rectangular pulse known as a pedestal, generated in the instrument. It is possible to make any echo occur at a time such that it will appear on the top of the pedestal, which may then be used to trigger a fast sweep occupying a length of time equal to the length of the top of the pedestal, offering an expanded sweep for closer echo examination. In the case of Fig. 2, however, the transmitted pulse is arbitrarily positioned near the extreme left-hand edge of the pedestal, which is broken and distorted downwards by "overshoot" voltages due to the intensity of the pickup from the nearby transmitter.



signal is the rough pulse group starting about 15 milliseconds to the right of the transmitter pulse. The "range" of the scatter signal in kilometers (i.e., distance to the scatter source along the path of the signal) is obtained by multiplying the delay time in milliseconds by 150. A delay time of 15 milliseconds (range of 2250 km) and an ionospheric layer height of 300 km would correspond to a skip distance of 2120 km.<sup>3</sup>

Echoes often appeared on these records, however, which were difficult to interpret. Range-time graphs could be made from them to facilitate sequential examination by laboriously plotting the range of each returned pulse or pulse group as a function of time of day, but interpretation difficulties were still numerous as the intervals between plotted points were too great to yield fine detail.

#### RANGE-TIME RECORDS AT A FIXED FREQUENCY

The range-time type of recording, in which an oscilloscope beam is intensity modulated and a film is moved past a slit along which the beam is positioned in proportion to echo range (delay time), corrected some of the faults of the above plotted graphs. Detailed time variations of scatter range in a given direction on a single operating frequency could now be seen although at considerable sacrifice of intensity information. Figure 2 illustrates such a record. The abscissas are time of day and the ordinates are delay time in milliseconds.

At the left-hand edge of the record (1840 EST) there appears a band of echoes between 11 and 17 milliseconds of delay time. These echoes are undoubtedly propagated via the F2 layer because, as time passes, the delay time (skip distance) increases, corresponding to the decrease in F2 layer ionization density with the approach of nighttime conditions, until at 2020 EST the skip distance becomes too great and the echoes disappear. At 1930 another band of echoes shows up at about 7 milliseconds. As time progresses the width of this band of echoes increases but it differs greatly from the first band in that the delay time of the leading edge remains fairly constant. Behavior of this sort could not take place if these echoes were reflected by one of the normal ionospheric layers. They must therefore be reflected by sporadic-E ionization. If only one observation had been made at, say, 2000 EST, the two echo groups might have been interpreted as propagated by one-hop F2 and 2-hop

<sup>3</sup>In simple one-hop transmission if scatter is from the distant ground, the range is proportional to the length of an equivalent triangular path from the transmitting point on the earth's surface to a midpoint in the ionosphere and down to earth at a distant point. The distance along the earth's surface between the two points is naturally less than this echo range and for a given range, is less the higher the height of the reflecting region. It can be shown that for this simple case the distance determined by the leading edge of the echo is approximately the "skip distance" for the radio wave at the particular frequency used, i.e., to a first approximation a radio signal on this frequency cannot be detected at a shorter distance in the direction of the scatter source from the transmitter. The skip distance can be determined from the range by a geometric calculation but it is simpler to use graphs or nomographs prepared for the purpose.

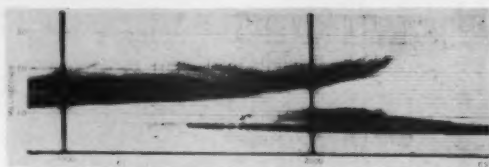


FIG. 2. Range time record of backscatter from northeast of Sterling, Va., on 13.7 Mc, October 2, 1952. This is a continuous record of the change of range to the echoing areas as time of day progresses. The straight black line at the bottom of the picture represents the transmitted pulse at zero range; the broad, heavy traces represent echoing areas at ranges corresponding to the delay times of the ordinates scale.

F2, respectively, with considerable error in skip-distance determination.

It was observed that the types of echoes varied greatly from one period to another. During quiet periods the echo on the range-time record was seen as a smooth, fairly thin line while during more disturbed periods it became a thicker and more wispy line (3). On extremely disturbed days these lines might at some times of day be replaced by streaks changing rapidly in range.

In spite of possible erroneous interpretations due to anomalous echo patterns, results of an experiment performed over a 2700-km path at 15 Mc in 1950, in which distant reception of station WWV was compared with backscatter measurements on pulse transmissions over the same path near the same frequency, indicated reliability of the scatter method of determining propagation conditions. For instance in 18 cases of observations of distant signal failure during the tests, the scatter at the correct range was visible in 17 cases and 13 of these scatter observations indicated the signal failure to within 15 minutes (3). This, however, was a special case of one frequency and one path.

#### PLAN POSITION INDICATOR (PPI) REPRESENTATION

The idea of using a radar-type plan position indicator for skip distance indication was first conceived by Dr. Newbern Smith of the National Bureau of Standards in 1945 (4) and independently in 1947 by Dr. J. T. deBettencourt (5), then at Raytheon Manufacturing Company. Each record obtained by this method is a plan view of the echo ranges in all azimuths for a single operating frequency at a particular time of day. The first experiment of this type was done for the U. S. Air Force by Raytheon, and the same experiment was performed independently by Villard and Peterson in the winter of 1951-52 (5, 6). Meanwhile work progressed on equipment of this type at the National Bureau of Standards, and it was first put into operation in the spring of 1952.

The Bureau's transmitter usually operates at 400-kw peak pulse output, although it is capable of a megawatt on short runs. The pulse width used is 40 to 50 microseconds. The rotating antenna is a double Yagi with vertical elements, and the receiver is a communications receiver adapted to pulse work. The antenna



rotates once per minute and a photograph of the resulting ppi representation is made. Use of a motion picture camera enables sequential study of the results. The high power and relatively narrow pulse width of this equipment affords better range-resolution of the scatter echoes than can be obtained with low-power equipment emitting long pulses.

One of the significant, though puzzling, characteristics of the echoes observed with this ppi equipment is that, as the antenna rotates, the range of the echoes seldom varies smoothly. The range, and therefore the apparent skip distance, sometimes jumps by discrete amounts of as much as 10 milliseconds as the azimuth changes. Also, at times, there are substantial azimuth intervals in which no echo is recorded at any range, without any indication of a transition between the echoes on either side. Figure 3 is a photograph of the ppi face at Sterling, Virginia, on December 28, 1952, at 1120 EST at 13.7 Mc. The rings are range markers at intervals of one millisecond. Toward the north (top of illustration) the range of the echoes is about 19 milliseconds (A), and remains fairly constant at first as the azimuth is changed clockwise, but in the northeast it moves in very rapidly to 12 milliseconds (B) and then more gradually to about 9 or 10 milliseconds in the easterly direction (C). Echoes at such ranges are difficult to interpret since they could contain ground-scatter echoes propagated by E, F1 or F2 layer. Beginning at the east and continuing around to the west (D) a heavy trace is generated with leading edge between 8 and 9 milliseconds. The shorter traces at 7 or 8 milliseconds toward the south (E) are no doubt ground scatter propagated by sporadic-E ionization. The strong echoes taper off just north of west (F), while another group at around 19 or 20 milliseconds, which first appeared just south of west (G), prevails with small irregular jumps all the way around to north.

Some of the irregular jumps may be due to focusing and defocusing effects of irregularities in the F2 region (7) or to varying amounts of defocusing caused by the changing intensity of sporadic-E ionization below the F2 layer (8). In fact, partial or complete shielding of the F2 layer by the E layer below it could cause gaps in the F2-layer echo range plot.

The high resolution of the system makes the fine structure of the echoes visible. The alternate black and white lines seen in any one photograph represent maximum and minimum amplitudes whose positions are relatively independent of the characteristics of the receiving system except that in the illustration some enhancement of the weaker echoes occurs at the range markers because of equipment characteristics. They are seen to shift as much as one or two milliseconds in position between one minute's sweep and the next. A wave interference phenomenon is evident here, the changes which take place being due to changes in the reflecting areas of the ionosphere as its irregularities change in position or shape.

One difficulty with the ppi system is that it conveys too much information at any one time even when

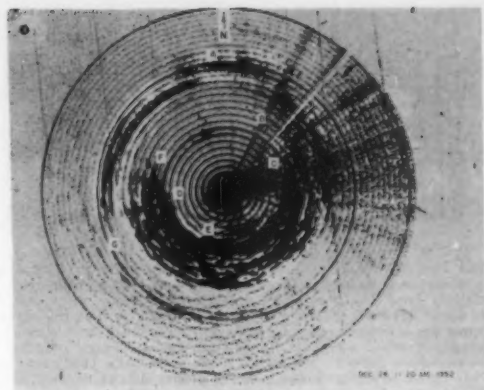


FIG. 3. Ppi recording of backscatter echoes illustrating discontinuities in echo ranges, and fading pattern. (Rings are range markers in steps of one millisecond delay time. Echoes are dark traces; ripple texture is due to instantaneous fading pattern of signal at different ranges. Fan-like traces in northeast and north are due to station interference; blank sector results from photographing; wavy lines of dots are caused by power-line interference.)

photographs are individually studied. To overcome this difficulty W. L. Hartsfield of the National Bureau of Standards has devised a scheme of projecting a ppi motion picture on a surface containing a slit with a translucent surface. This slit can be set at any azimuth and, to the lens of a range-time recording camera, appears just like the face of an oscilloscope tube reproducing echoes at a fixed azimuth in a range-time recording system. Thus the ppi photographs become the potential source of range-time recordings over any desired azimuth. It is merely necessary to photograph the slit on the moving film of a range-time camera.

In common with all scatter-sounding systems employing the usual directive antennas with beam widths of the order of 20 or 30 degrees, the ppi system suffers from the difficulty that if such an antenna is pointed in a given direction and the range to the scatter in an adjacent direction is shorter, there is often enough energy from these shorter-distance echoes to falsify the range for the azimuth being recorded (9).

Also as was noted for range-time records, there exists the possibility of false mode interpretation and consequent erroneous skip distance determination. For instance, echoes with delays of the order of 10 milliseconds may be propagated by the F2 layer or the F1 layer or the E layer. A mistake in assuming F2-layer propagation at that delay when sporadic-E ionization is really responsible, would be followed by an erroneous virtual height assumption, giving a calculated skip distance about 7.5 per cent too short and any forecast of failure time of point-to-point transmission at the same frequency would probably be completely in error.

Studies are now being conducted at the National

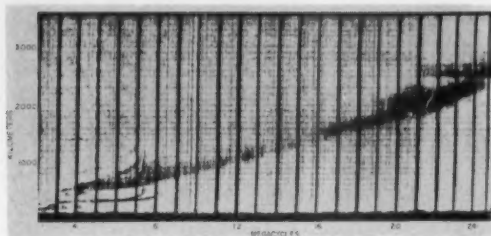


FIG. 4. Typical sweep-frequency record made at Sterling, Va., Dec. 15, 1952, at 1258 EST, showing regular vertical-incidence echoes and backscatter echoes. Waves returning directly from the ionosphere give the thin trace observable at about 250-km range in the lower left-hand part of the picture. These traces turn upward at 7.3 and 8.0 Mc. Waves returning after striking the ground and bouncing off the ionosphere a second time create a trace at twice this range. This trace, however is obscured by diffuse echoes developing into a plume-like trace receding to about 3000 km at 25 Mc. These echoes are backscatter echoes.

Bureau of Standards on several months' ppi films to see if disturbance forecasting or tracking, originally proposed by NBS workers (3), is feasible. Other objectives of the work are to evaluate the ppi as a skip-distance indicator and to increase the knowledge of ionospheric phenomena in general.

#### SWEEP-FREQUENCY BACKSCATTER RECORDS

The sweep-frequency technique represents the latest approach by the Bureau to the study of backscatter. Occasional records of backscatter out to great distances were obtained as early as July 1951 using a standard NBS Model C3 ionosphere recorder modified for a 12-minute sweep and operating with a rhombic antenna beamed to the west. Results in this work were considered marginal, however, because of insufficient signal-to-noise ratio, until improvements in the recorder made it possible to obtain usable records on a fairly continuous basis during the winter.

In the range-time type of recording at a fixed frequency and azimuth, echo identification can sometimes be accomplished only by observing the change of the record with time of day, as ionization conditions change. However, in the sweep-frequency type, the change of frequency during a single sweep, by continuously changing the ratio of the operating frequency to the critical frequency of a given layer, accomplishes the same thing in the course of a single sweep. Thus it is possible to see the scatter "grow" out of the traces of the regular vertical incidence reflections and each mode of scatter propagation develop as the frequency increases.

A test originally described by Dieminger (10, 11), and later by Peterson (12), for establishing whether backscatter propagated by a given layer was from the ground, was tried on a large number of sweeps, verifying that at least just beyond the critical frequency of the F2 layer the scatter was from the ground.

A simple sweep-frequency scatter record appears as shown in Fig. 4, the ordinates being virtual height or slant range in km, and the abscissas frequency. The ordinates are marked every 100 km and the ab-

scissas in megacycles, running from 3 at the left to 25 at the right. The thin solid curves at the left of the picture are the well-known virtual-height versus frequency curves for the ionosphere overhead. The F2-layer ordinary-wave critical frequency is about 7.3 Mc. The second trace above the bottom of the graph, similar in shape to the first, but diffuse on top, is the second (2-hop) reflection. The weak and more diffuse looking echoes which start out along an imaginary straight line from the origin (off the diagram) running tangent to the bottom of the second-multiple F2 trace are the ground scatter echoes reflected by the F2 layer. These run all the way out to 24.8 Mc where the slant range is 2400 km. The F2-layer skip distance for any frequency is obtained from the slant range by using curves of tabulated values of slant range vs skip distance for various virtual heights of the reflecting layer. In this case for an F2-layer virtual height of 300 km the skip distance would be 2260 km.

Attention is called to the group of echoes starting at about 21 Mc, behind the line of the regular F2-propagated echoes. These echoes appear at about the same distance on a great many records. Their slant range is fairly constant and their calculated distance agrees with the distance to the Rocky Mountains from the transmitter site at Sterling. It may be possible to use the variations in their apparent range as an indicator of ionospheric conditions.

On some records it is possible to distinguish ground scatter propagated via the F1 layer and the E layer as well as by the F2 layer.

Because of the sweep-frequency feature it was possible to check the reliability of backscatter echoes for skip-distance determination a great many times in one day, since a distance could be selected which would be the skip distance for some frequency in the recorder sweep at any time during the day. The path chosen for the test was the 1150-km path from Sterling, Virginia, to a point near St. Louis, Missouri, since this had been the path for two-way pulse experiments with the same equipment. The St. Louis equipment had been dismantled but satisfactory use was made of the vertical-incidence ionosphere recorder situated at the midpoint of the path near Batavia, Ohio. Previous experiments had shown that the Batavia data could give the maximum usable frequency (i.e., skip-distance frequency, abbreviated as MUF) for the St. Louis path with reasonable accuracy (13). Also during part of the experiment, transmissions from station WWV located near Washington, D. C., were recorded at St. Louis and afforded a very satisfactory check of MUF.

Comparisons of skip distance deduced from sweep-frequency backscatter and from the midpoint data were made for a period when the ionosphere was relatively calm and there was little sporadic-E ionization. Comparisons were also made for another period when the ionization values were fluctuating greatly throughout the day and much sporadic-E ionization prevailed. In the former case agreement between the values of

MUF obtained by the two methods was very close—within 5 or 6 per cent in most cases. In the latter case agreement was extremely poor. Values of MUF obtained by the scatter technique were always higher by varying amounts, sometimes of the order of 50 per cent. The scatter records, too, were vastly different from those made on calm days. Instead of being straight and thin they were relatively crooked and broad, often exhibiting at least two branches, and their configuration changed from one sweep to the next. Oddly enough, however, the skip-distance comparison for most of these records gave results which would be consistent with reflection from the top of the distant E layer although the traces at nearly vertical incidence from which the echoes emerged as the frequency increased appeared to be reflections from the ground.

Some of the poor results and branched traces for the disturbed day may have been due to the breadth of the antenna beam and the turbulence of the ionosphere. On a disturbed day there would undoubtedly be many regions off the beam, especially to the south, with higher ionization density than that for the path midpoint at any one moment; some of these regions would be capable of propagating ground scatter in sufficient intensity to appear as echoes of lesser delay times than the great-circle echoes. The possible use of sweep-frequency backscatter to study, track and forecast radio disturbances is indicated here (3, 6).

The equipment, with the relatively small rhombic antenna which was used, proved to be inadequate for nighttime operation when the skip distance at the lower high frequencies was long, requiring a very large rhombic antenna, radiating at low angles.

Future plans call for backscatter experiments over the path from Sterling, Virginia, to Boulder, Colorado, in conjunction with a two-way pulse propagation ex-

periment. Since Boulder is at the edge of the Rocky Mountains it should be of value to see how variations in the range of the fixed echoes compare with variations in two-way signal transit time and backscatter delay time.

Results of all experiments to date corroborate the author's views expressed in an earlier report (3) that there will be times when skip distance determination by backscatter delay will be difficult or impossible, and it now appears that such circumstances may be rather frequent. Two things are certain. One is that skip-distance determination by scatter techniques can be done only by a skilled person familiar with the regular behavior of the ionosphere in the region. The other is that a great deal of further experimentation will be needed under a variety of circumstances before the value of the technique is finally assessed.

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## Introducing a New Editor of the A.A.S. Journals

For some months the editorial direction of SCIENCE and THE SCIENTIFIC MONTHLY has unavoidably been of a temporary character. The Acting Chairman of the Editorial Board is therefore glad to be able to announce the new and permanent appointment of Dr. Duane Roller as Editor of both journals and Chairman of the Editorial Board.

Dr. Roller received the Ph.D. degree in experimental physics from the California Institute of Technology in 1928. He has taught physics at the University of Oklahoma, Hunter College, and Wabash College, and has been visiting lecturer at Harvard University and at the Case Institute of Technology. During World War II he served with the Armor and Ordnance Divisions of the National Defense Research Committee. Dr. Roller founded and for 15 years was editor of *American Journal of Physics*. He is a co-author, with Millikan and Watson, of the textbook, *Mechanics, Molecular Physics, Heat and Sound*, is co-translator and editor of Vols. 2 and 3 of Cranz's *Lehrbuch der Ballistik*, and is the author of three monographs and numerous articles.

Duane Roller's interests extend into the areas of the history, methodology, and language of science. In 1946 he received the Oersted medal for outstanding contributions to college and university physics teaching, in 1949 was President of the American Association of Physics Teachers, and in 1952 was awarded an honorary degree by Hamline University for his contributions to physics as a part of liberal arts education. He has held fellowships of the General Education Board and the Ford Foundation. Currently he is a member of the Governing Board of the American Institute of Physics and of the Board of Trustees of Science Service. Since July, 1952, he has been Assistant Director of the Hughes Aircraft Research and Development Laboratories.

These broad interests and wide experience eminently qualify Duane Roller for his new task as Editor. Under his leadership SCIENCE and THE SCIENTIFIC MONTHLY should attain new distinctions in scientific reporting and in keeping a widening audience aware not only of the achievements of science, but of its nature, methods, and spirit.

BENTLEY GLASS

# Scientific Property

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**P**ROPERTY RIGHTS ARE SECURED by authors and inventors for their intellectual creations through copyright registration and patents. One covers literary works of esthetic character; the other the useful arts, manufacturers, compositions of matter, and asexually reproducible plants. A scientific creation, even, though it is the basis of great industrial and social progress, financially rewards its creator only through indirect means. A scientist may patent inventions or copyright scientific papers to secure legal rights in these less important results of his research. Title to a scientific discovery is not given a scientist.

*Copyrights.* A copyright is an exclusive privilege which the law allows an author to print or otherwise multiply, publish, and vend copies of his own original work. It lasts for twenty-eight years with a privilege of renewal for fourteen more. The right may be assigned by a written instrument duly attested and recorded.

Copyright privileges offer no advantages for the scientist. In fact, not only do publications of scientists in the learned journals not result in royalty income, but the scientist must also help defray the cost of his publications. This is for his important original scientific contributions and not for such expositions as popular articles in magazines, elementary textbooks, and treatises. The latter probably are of literary character.

Recognition for contributions to science is the actual reward to a scientist for his work. Publication may be looked upon as a type of advertising by which a scientist rises in the ranks of his fellows, but otherwise there is no financial gain. Some new scientific finding may be expounded in copyrighted treatises which helps to sell them. But even here the practical value of publishing a treatise is that the scientist's work becomes known more widely and credit is given to him for possessing a creative mind and distinguishing him as a scientist.

*Patents.* A patent is a legal monopoly granted on the theory that its existence will promote the progress of science and the useful arts. The law concerning patents is highly technical and complex. It concerns the way in which patents are issued and the rights and duties flowing from their issuance. They are given for inventions, again a technical and complex concept.

Invention consists of the application of known principles of knowledge to new facts, situations, or materials, in order to achieve some useful result. This is to

be contrasted with discovery—a mental process beginning and ending in the realm of the mind. Discovery itself cannot result in any material application of the newly found knowledge, since then invention is involved. The scientist concerns himself primarily with discoveries not inventions. He thus excludes himself from the rewards of his discoveries unless he makes inventions.

A patentee, through the patent, obtains a legal right to exclude all others from making, using, and selling his patented products or processes. This is an economically valuable property right. Of course, an inventor has a right to make, use, and vend his invention even without a patent. He may deprive the public of the benefits of his invention by keeping it secret. He does not have, however, an exclusive right unless he is also a patentee. A scientist making a discovery must apply it to an invention that he must then patent to assure himself of a financial reward. As a patentee, he is in a strong position, but this is usually a minor matter to a scientist. It consumes his time and effort to secure this right. We at once realize Louis Agassiz' meaning when he replied to a friend who suggested that he avail himself of a tempting financial arrangement: "I have no time to make money." Agassiz had too much to do in making scientific discoveries, let alone making inventions, taking out patents, fighting legal actions, and otherwise consuming his valuable time. It is to be remembered that it was Agassiz who did so much to advance the concept of coal-bed formation during his exploration of the Dismal Swamp in Virginia, an important concept for future geological exploration to find coal deposits.

This series of events may be extended even farther from the point of discovery of a basic new scientific principle which cannot be patented. As already noted, only an application of the scientific principle may be patented. Although possessing a legally sound patent covering part of his scientific research, the scientist must devote considerable effort and thought if he is to exploit commercially his patented invention.

Patents are intangible and fragile property which cannot be valued in the same way as other property. It may be sold outright, licensed, or a nonprofit business established under it. In any case, an economic venture must be undertaken which is not research but management. Competition is keen—there are a half million U.S. patents in force today. It must be protected. It must not infringe upon other patents. Risks are involved. It is easy to see that the value of a patent to a scientist is not worth the trouble and time required to exploit it, if he is to remain a scientist.

An advertisement in *The Scientific American* in

<sup>1</sup> The views and opinions expressed herein are those of the author and not necessarily those of the ICSRD or of its member agencies.



December of 1951 announced an offer of research facilities to inventive Americans who need them: "If you have an idea of this kind (within the petroleum field) you are invited to submit it to the Sinclair Research Laboratories, with the provision that each idea must first be protected, in your own interest, by a patent application, or a patent. . . . If the directors of the laboratories select your idea for development, they will make, in most cases, a very simple arrangement with you: In return for the laboratories' investment of time, facilities, money, and personnel, Sinclair will receive the privilege of using the idea for its own companies, free from royalties. This in no way hinders the inventor from selling his idea to any of the hundred of other oil companies for whatever he can get." This plan apparently recognizes the greater ultimate value of a discovery or of an idea than the more tangible application of the discovery which is patentable.

Popular belief has it that the patent system was established in order to reward inventors. This is not so. Reward to the inventor is merely the incentive by which the law tries to secure the progress of science and the useful arts as provided in the Constitution.<sup>2</sup> The patent system of the United States is based on the theory of getting information. It rewards the inventor only in recognition of his services in making a new idea available to society. Compensation is incidental, but tangible, and available to a scientist who wishes to make the most of this least important result of scientific research. Apparently society at large deems it sufficient that a scientist in simply being allowed to disclose his truly important findings, is rewarded enough (1).

*Right to Credit.* Looking beyond patents and copyrights one finds that scientific research results in a kind of scientific property which is not patentable, nor capable of being protected by copyright. A well-known symbol in physics,  $h$ , represents a fundamental physical quantity. To scientific society it is Planck's constant. The classical laws of motion are called Newton's laws in honor of this famous scientist. These are examples of rewards for scientific discoveries. The creators were honored through association of their names with their achievements. It is common to find scientists' names associated with effects, equations, or other facets of scientific achievements which symbolize these achievements. These are the real rewards to scientists and they indicate existence of scientific property.

The evanescent honor of association of one's name with his scientific achievement is not a right; it is conferred by an appreciative society but there is no law to protect a right to credit. Indeed credit might shift by virtue of public misunderstanding or more vigorous advertising on the part of one of the parties trying to establish credit for creating a new scientific advance. Economic reward is wholly lacking unless the intangible one of position in the ranks of one's

fellow scientists is considered ample compensation. Future earning capacity is probably thereby increased. Certainly, sponsorship of scientific research is influenced by the rank of a scientist applying for financial support. This is a typical economic advantage which leads one to regard credit for achievement as a property value. One has only to recall the famous argument between Newton and Leibnitz over priority for credit for discovery of the differential calculus to realize their regard of the property value of such credit. Galileo also diligently protected his inventions and discoveries and was forced upon occasion to publish accounts of plagiarism. In fact his first printed work on "The Operation of the Geometrical and Military Compass" was written to end a dispute as to his invention of this instrument and his later published account of this so-called Capra plagiarism was written firmly to establish his priority of this invention and certain astronomical discoveries (2).

A close approximation in business activity to the concept of right to credit would seem to involve trade marks. A trade mark is a distinctive symbol affixed by a tradesman in some way to the goods he manufactures or has caused to be manufactured so that they may be identified and known in the market. The mark is registered with the Patent Office and may be renewed each fifteen years. Industry relies upon trade marks to protect it as it tries to build valuable goodwill credit. Conflicts of interest between industrial groups are not infrequent over the ownership of trade marks under which articles are sold. This is for the reason that a name increases in value with every sale. The trade mark owner of a successful commercial product is in an exceptional bargaining position. For example, a manufacturer trade mark owner can turn to other distributors if it is favorable to do so. Also, if the distributor is the owner he can easily find other manufacturers if this is within his interest. Trade marks give real advantages, and they are property. They give significant and valuable protection to a right to credit arising from creating successful products. The scientist, however, is protected only by ethics, not law, even the vague law that applies to businesses through trade mark legislation.

Actual publication in channels that dedicate scientific discoveries to the public is not the sole index of establishment of a right to credit. Much research today is done under blankets of military security. Achievement is thus often excluded from the public eye, although a close circle of an investigator's fellow scientists knows of the accomplishment. Government document centers distribute catalogs and abstracts of classified reports to disseminate knowledge of such accomplishments. The circle is widened thereby, but the finding is still not dedicated to the public at large.

A scientist may have no legal protection for credit, but the work is considered his work through general recognition, at best public recognition, and a property value exists in this recognition. This is scientific property. Indeed, it meets a most practical test—taxation is involved.

<sup>2</sup> "The Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." (Art. I, Sec. 8)

Recipients of foundation grants to apply their skills and training to advance research are subject to income taxes. Stipends received under fellowship awards from research foundations involving only education or training of the recipient are excluded, as the award is considered to be a gift. It is apparent that research results are valuable items, as valuable as such side issues as patents and copyrighted articles which are mere applications of the results. The research product possesses property value, and the creator and his sponsor are engaged in an enterprise that is very much like a bonafide business (3).

Apparently, scientific property exists at the moment of the scientist's original conception. Professor B. Van der Pol stated recently (4), "Some time ago in Holland an inquiry was made asking whether, when any new thought in science occurred to one, a new idea occurred in words or not. The question was also addressed to me. My answer was positively *no*, because it often gave me considerable pains, after a new thought had occurred to me, to express it in words to friends." Intellectual property is thus created without form and probably never is embodied in words or materials as are esthetic works or patentable devices.

The law does not protect ideas. Judge L. Hand has clearly analyzed the situation and draws the following interesting analogy (5): "If Twelfth Night were copyrighted, it is quite possible that a second comer might so closely imitate Sir Toby Belch or Malvolio as to infringe, but it would not be enough that for one of his characters he cast a riotous knight who kept wassail to the discomfort of the household, or a vain and foppish steward who became amorous of his mistress. These would be no more than Shakespeare's 'ideas' in the play, as little capable of monopoly as Einstein's Doctrine of Relativity, or Darwin's Theory of the Origin of Species. It follows that the less developed the characters, the less they can be copyrighted; that is the penalty an author must bear for marking them too indistinctly."

The scientist's rights to his creations demand moral duties on the part of society, although he does not possess legal rights. Since credit is valuable, a scientist is loath to disclose fully his creation until he has solidified his position. When recognition comes, he quickly discloses all aspects of his research.

Credit is the mark of creative genius to distinguish an investigator in the ranks of his fellow scientists. He must secure this value to make his reputation and thus to profit from his labor.

Early workers used anagrams to conceal findings, yet to declare in print their creations. Thus Hooke announced his law in the form: *ceiinoosstuv*, which, when arranged becomes *ut tensio sic vis*. Today's technique is by advertising through "letters to the editor," or scientific notes are distributed ahead of full publication to establish credit; for example, through a technical report to sponsoring agencies of research.

*Duties of the Scientific Administrator in Regard to Scientific Property.* The scientific administrator is particularly aware of this situation (6) and is acutely

concerned with the problem of scientific property. Scientific administration is the name of a new profession—that of the scientist in the Office of Naval Research, the National Science Foundation, or similar organizations concerned with a program of contracted research. He is, in many ways, like the business manager described in Oswald Knauth's book (7).

Knauth describes a business manager as a mediator in behalf of the company as an institution who deals with concert and conflict between owners, employees, customers, and government. His decisions affect them all, the future of the corporation, and perhaps even the general welfare of the nation. His profession is a new one and not subject to clear sets of standards. He has a wide margin of discretion in which to make decisions so long as they do not wreck his enterprise. He is not strictly bound by the old and clear imperatives of competition, and nothing very definite has been substituted for them. His intuition is usually correct, although little assurance is given in a given case that his ideas are the best ones.

The scientific administrator is in a similar but more evanescent position. For example, he must mediate in the interest of his agency between the requirements of science, the universities, the scientists, and the nation. His decisions are likewise largely guided by intuition and, within the framework of the larger organization, he has a wide margin of discretion in which to operate. He must respect and guard any privileged communications to protect the intellectual property of his correspondent. Since his position in the world of science is that of catalyzing the advance of science, he must not stifle it by betraying confidences which might jeopardize the sole property value that a scientist obtains from his work—his credit.

The advance of science requires the constant interchange of ideas to engender new ideas. The scientific administrator tightens lines of scientific communication (6) by telling of current work in progress often before public announcement of a line of work by an investigator. He may tell of new techniques or discoveries before credit has been firmly established through publication and thus lose for an investigator his right to credit should a competitor seize upon the idea and then advance and establish it as his own. He may, on the other hand, help establish such credit, since credit exists only when recognized by scientific society and he is a link in scientific communication. In either event, the scientific administrator is in a privileged position, and he must judge between these conflicts of interests. Should he tell of learning of a scientific finding in the interest of furthering interchange of ideas or keep the matter to himself in interest of assuring that the right to credit will not be misplaced? Ethics are difficult to specify. Depth of understanding is involved, for a trivial advance may be considered major in the eyes of an investigator.

Institutions submitting reports to supporting agencies often call attention to their disclosure rights by limiting circulation with such words as: "This report is a private communication and must not be repro-



duced in whole or in part without special permission," or "It is urgently requested that no public reference to these disclosures be made until after their publication and that such references then be made to the periodical." The property value of the scientific findings is clearly behind such concern. The scientific administrator is not here concerned with an academic problem, far from it, tangible value rests in the right to credit. It is scientific property.

**Legal Protection of Scientific Property.** There have been attempts to secure legal rights for protection of scientific property. Since science is international in character, these are difficult to resolve, let alone achieve. Scientific councils, in justice to persons making scientific discoveries, have deliberated the problem which will enable scientists to secure economic benefits from the industrial progress based on their discoveries. The nature of such protection for the creations of the mind, over and above that enjoyed by authors of artistic or literary works and by inventors, is more difficult to define than protection given by copyrights (7) and patents, or even trade marks. It was suggested, for example, that scientists whose discoveries are applied industrially by others, should be remunerated out of a fund formed from subscriptions paid by, or contributions levied on, the industries profiting by the discoveries (8).

The question was raised in 1928 by the Committee on Intellectual Cooperation of the League of Nations: Shall the scientific discoverer be recognized legally and rewarded materially and, if so, how? The National Research Council, being representative of the leading scientific organizations in the nation, was asked to express its views. Two considerations were raised. Is this desirable? Is it feasible? The latter consideration took particular note of three plans.

The Ruffini plan which provided for granting a quasi-patent right to the discoverer of a scientific principle entitling him to a share of the profits accruing to an inventor who makes use of that discovery in some application for which he obtains a patent. The Casares modification of this plan which limited this right to cases in which the scientist foresees its commercial exploitation and places on record a specification of its application. The third plan was identified as the Torres Quevedo and Bariel proposals; it suggested awards to scientists for their discoveries from a state fund formed by contributions levied on the profits accruing to patentees or industrialists from the use of these discoveries.

At its April meeting in 1928 the Executive Board of the National Research Council moved: That the Permanent Secretary be instructed to reply to the Secretary of the American Committee on International Intellectual Cooperation to the effect that the National Research Council found that it was the almost unanimous opinion of its members that the protection by law of a scientist's property rights in his discoveries was not feasible, and was of doubtful desirability. This action was based on consultation with each of the divisions of discipline within the Council. The

opinion of the Division of Chemistry was typical in that it felt that it was neither desirable nor feasible to give property rights to American scientists in their discoveries other than those assured by the principles of present patent and copyright legislation.

Twenty years ago the AAAS Committee on Patents, Copyrights, and Trade Marks consisting of Joseph Rossman, chairman, F. G. Cottrell, A. W. Hull, and A. F. Woods studied this problem and concluded "that no effort should at present be made to develop a plan for protecting scientific property." Its forty-page report (9) discusses fully the problems raised again here.

A proposal in 1951, striking at the problem by re-examining such general principles and thus protecting a discoverer rather than an inventor or author, was so to amend and extend the copyright laws that right to credit is a legal right (10). The present law does not give authors the right to require that their names be published in connection with their writings unless a contract exists. A scientist thus has no recourse if his article is published without his name. Revision of the copyright law is necessary to give the scientist a legal right requiring that his name be associated with his scientific writings (5).

Ilovay's recent paper (1953) based upon a UNESCO report indicates that the issue is currently of international concern (11). This splendid paper written from the legal frame of reference penetrates deeply into the problem discussed here. The subject is obviously complex and any formal solution will be difficult if not impossible. However, conversations between scientific administrators and research scientists frequently, if not on each occasion, drift to this topic in many guises. Administrative solutions of problems, as they arise, may be made by noting analogous situations in areas where there is a body of formal tradition. For example, in the frequently occurring problem of multiple authorship of scientific papers, a decision as to the senior author, or whether to include associates as co-authors, might be resolved by following the practice of determining who are inventors. Clearly the rules governing decisions as to priority of invention are useful to resolve arguments of right to credit. Such rules in their more ancient form were undoubtedly used by the University of Padua committee in determining the priority of invention and discovery in the Capra plagiarism (2).

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## News and Notes

### Meeting of the Society of General Physiologists: Symposium on Photoperiodism

THE Annual Meeting of the Society of General Physiologists was held at the Marine Biological Laboratory, Woods Hole, Sept. 11-12. The 75 registrants devoted the first day to short research papers and the second to a stimulating symposium on Photoperiodism, arranged by Sterling Hendricks in cooperation with the Committee on Photobiology, National Research Council.

At the business meeting it was voted to affiliate with the AAAS. It was also decided to meet at Woods Hole in 1955 in conjunction with the meeting of the American Physiological Society at Tufts Medical School. The results of the mail balloting for officers and council were announced (see p. 3 of this issue of SCIENCE), and it was reported that Woods Hole had won narrowly over Gainesville as the meeting place for 1954; that the Society had been invited to nominate two members to the editorial board of *Physiological Reviews* (F. A. Brown, Jr. and Folke Skoog were selected); and that the members of the Society are ex officio members of the International Union of Physiological Sciences, and entitled to participate in the next Congress. After the meeting the Society enjoyed a social hour at the home of Dr. and Mrs. A. Szent-Györgyi.

The contributed papers consisted of the following: "Electrical measurement of oxygen exchange in respiration and the photosynthetic energy cycle" (D. Burk, K. Damascus, F. Toedt, and O. Warburg); "Participation of photosynthesis in the physiology of *Ochromonas*" (J. Myers); "The effect of the illumination conditions on behavior in a gradient of temperature" (C. M. Sullivan and K. C. Fisher); "The nature and kinetics of the respiratory pigments of the luminous bacterium, *Achromobacter fischeri*" (B. Chance and V. Sidel); "A quantitative study of the distribution of sulfhydryl groups during embryonic development" (J. H. Bodine and C. Norman); "Discontinuous respiration in diapausing *Agapema* pupae" (J. B. Buck, M. L. Keister, and H. Specht); "Structure and function of the nuclear membrane" (W. R. Duryee); "Facilitated transfer of sugar across the erythrocyte membrane" (W. F. Widdas); "The asymmetrical penetration of water through insect cuticle" (A. G. Richards); "The  $Q_{10}$  of the maximum developed tetanic tension of isolated single muscle fibers of the frog" (R. W. Ramsey, M. A. Washington, M. F. Arrighi, and S. F. Street); "Ca, Na and K concentrations in the cathodal and anodal portions of *Physarum polycephalum* during galvanotaxis" (J. D. Anderson, J. V. Butkiewicz, and E. C. Roter); "Rabbit blastocyst alkalinity and implantation" (B. G. Böving); "Kinetics of the thermal in-

activation of isolated chloroplast fragments" (J. D. Spikes, N. I. Bishop, and R. Lumry).

The Symposium on Photoperiodism demonstrated the fundamental kinship between plants and animals in the mechanisms of certain responses to light and in the operation of various adaptive endogenous rhythms. The contributions also illustrated well the fruitfulness of three levels of attack: measuring carefully the responses and rhythms and relating them to environmental cycles; tracing the overt phenomena to underlying physiological changes, notably in hormone level; deducing, from quantitative spectrophotometry, the nature of the active pigment and the molecular changes involved in the basic photochemical reaction.

In a variety of plant material, H. A. Borthwick reported that the same action spectrum, with maximum effect at 6500 Å, was obtained for induction of seed germination, for seedling growth, and for both the induction of flowering in long-day plants and its inhibition in short-day plants. The effect of 6500 Å light was completely and repeatedly reversible by infrared light of wavelength 7350 Å.

This photoreversible reaction was further studied by S. B. Hendricks and shown to be temperature-independent and obedient to the reciprocity relation. Hendricks regards the pigment, which is present in exceedingly low concentration, as probably a tetrapyrrole related to phyocyanin, and the photoreaction as probably a cis-trans isomerization, with the biologically active molecule being the excited intermediate form rather than either the more stable (6500 Å) or less stable (7350 Å) isomer.

One link in the complex chain of reactions between photosensitive molecule and biological end-phenomenon may involve hormone action, judging from the work of A. W. Galston. It was found, for example, that light produces a rise in the growth-promoting auxin indoleacetic acid (IAA) and that the experimental application of IAA is equivalent to the action of light in inducing and in inhibiting, respectively, the flowering of long-day and short-day plants. A further step in biological complexity, the origin of endogenous rhythms, is suggested by Galston's finding that rhythmic responses originally induced by photoalteration may persist in uniform conditions, apparently via alternating rises in concentration of IAA and its adaptively-induced enzymatic inhibitor, IAA-oxidase.

From a review, by C. E. Jenner, of animal responses to seasonal changes in length of day or night, it appears that knowledge of the basic reactions lags behind what is known in plants, although the biological variety and complexity may be even greater in animals. The only two action spectra adequately investigated—those for induction of spawning in a freshwater snail and a marine hydrozoan—show absorption maxima at 4200, 5000, and 6250 Å, suggesting porphyrin involvement. Animal photoperiodism thus

seems to depend on a different photochemical reaction from that in plants.

F. A. Brown, Jr., described a number of remarkable rhythms in marine invertebrates that, for weeks or months, persist in accurate synchrony with environmental cycles even though the animal is in uniform conditions. In the eyes of certain shrimp, for example, the retinal pigment migration shows clear cycling not only according to diurnal light-dark alternation, but with the daily and fortnightly tidal cycles as well. A basic endogenous rhythm is postulated, which controls both the sensitivity of the eye and the hormonal cycle that in turn controls pigment migration. Similar rhythms of oxygen uptake have been found in crabs and snails.

A three-component cycle involving interaction of diurnal and endocrine components is illustrated in the egg-laying activity of the hen, described by R. M. Fraps. Here the neural component stimulating the pituitary to release the ovulation-inducing hormone has a diurnal rhythm of threshold for excitation by hormones from the ovarian follicle. Due to lag in the production of the follicular hormones after ovulation, each successive neural-pituitary-ovary chain of stimulation occurs later than the preceding, and eventually the chain is broken for a day—that is, the hen skips a day in egg-laying—because the neural element is in the refractory part of its diurnal cycle at the time of day the follicle hormones arrive.

In the eclosion of *Drosophila* at the end of pupal life there appear to be two inherited and persistent "clocks" involved. One measures time in 24-hr periods, normally with respect to dawn, but subject to experimental resetting; the other measures time between dawn and a time at which a favorable humidity would normally be attained. In describing these clocks, C. S. Pittendrigh showed that the 24-hr clock is temperature-independent between 5° and 29°, and the other clock temperature-dependent; and that these facts have adaptive significance.

JOHN BUCK

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## Science in 1953 as Presented to the Public

This summary of progress in science and technology in 1953 consists of items selected and adapted from a 355-item list prepared by Science Service for distribution to its newspaper clients. More information about any item can be obtained by sending two 3-cent stamps for each item to Science Service, 1719 N St., N.W., Washington 6, D. C.

### Aeronautics

Work progressed on an automatic radio transmitter beacon that goes into action when a plane crashes; combined with automatic ground-based direction-finding stations, the beacon will serve to pinpoint the scene of future airplane crashes, permitting rescues

in record time. ¶ A plastic-treated material of glass fibers was found to be successful for airplane construction, saving on construction cost, permitting faster flight and making airplanes "invisible" to radar. ¶ Tests were successful on models of a new type of airplane wing, resembling Venetian blinds, that will enable a fast transport plane to make a vertical take-off from a small airport. ¶ A prototype of the F-100 Super Sabre, now in production for the Air Force, attained supersonic speed in performance; it set a new official record of 754.98 mi/hr. ¶ The experimental Douglas D-588-II Skyrocket set a new unofficial record of 1327 mi/hr by flying twice the speed of sound. A new altitude record was set at 83,235 ft in an experimental plane. ¶ A swept-winged guided missile was developed capable of striking at supersonic speeds from submarines, surface ships and shore bases. ¶ Devices were developed for guided missiles which automatically correct navigation errors due to faulty construction, winds, changes in air density and other factors that might throw the missile off course. ¶ Two Navy guns were paired into a team automatically loaded, controlled electronically by the ship's radar and fire-control system, and capable of spitting heavy flak at guided missiles. ¶ A new synthetic lubricant was developed for jet engines that will enable designers to create fighter planes that can fly higher and faster and operate in Arctic as well as the tropics. ¶ Synthetic lubricants from pine gum were found useful in the extreme cold of the Arctic. ¶ Zirconium dioxide powder was stabilized to withstand the extreme heat of jet engines and rockets. ¶ An electronic "brain" was invented that will compute the arrival time of airplanes at an airport and, in event that two planes arrive simultaneously, will figure out a slight detour for one. ¶ A robot pilot was developed to control the flight of a heavy plane from take-off to landing using flight data coded on a punched paper tape. ¶ A new kind of radar that responds to airplanes but not to stationary objects such as buildings went into operation as a landing aid. ¶ A sled that can travel at twice the speed of sound was created to test the design of new parachutes for jet planes.

### Anthropology and Archaeology

A fragment of bone of the most ancient true man so far known, some millions of year old and found in South Africa, was cleaned and readied for scientific study. ¶ Fresh evidence that the "Taungs Baby" was more human than ape was provided by a mathematical study of the dimensions of the milk canine teeth. ¶ A complete rib of 12,000-year-old Folsom Man was found in New Mexico with the skeletons of three dire wolves which had probably killed him. ¶ Bones of the Old Stone Age infant were found in a cave in Iraq; the cave is now inhabited and has been continuously for some 100,000 yrs. ¶ Human weapons and tools found in the frozen soil of Alaska were dated by geologic methods as being from 3000 to 7000 yrs old, belonging to a period when the climate was much

milder than it is today. ¶ Further evidence of a pole-girdling migration of early man from Europe through Siberia, Alaska and Canada to Greenland was seen in delicately made burins found near the west coast of Hudson Bay. ¶ The jaw of Piltdown Man, the "Dawn Man" of Sussex, was definitely proved to be a hoax; the other skull fragments are authentic but not more than 50,000 yrs old. ¶ Fluted weapon points of the type known as eastern Folsom, relics of people who lived some 7000 yrs ago, were found near the Roanoke River in southern Virginia. ¶ Evidence in the form of associated extinct animal bones showing that the ancient men who were makers of the "Clovis" points were hunting in America more than 15,000 yrs ago was reported; similar evidence showed that Folsom man, although more recent than the Clovis people, lived in America long before Yuma Man. ¶ The first known Indian-carved nude figure of a woman found on the face of a canyon wall showed the marks of smallpox eruption and commemorated the recovery of the woman. ¶ The practically unknown people of the upper Xingu River, in Brazil's Mato Grosso were visited by a party of anthropologists and found to be dying out. ¶ Technical experts recommended the new use of 2000-year-old cisterns to store water to reclaim the Negev desert area in Israel. ¶ A cooperative x-ray study by medical and anthropological experts of Indian bones in the Smithsonian Institution was undertaken; it is expected to show whether tuberculosis and syphilis are native in America.

*Astronomy* [See H. Shapley's "Astronomical Highlights," *SCIENCE*, 118, 738 (Dec. 18, 1953).]

#### *Biological Sciences*

The manner of duplication of chemicals that carry on heredity within the germ cells was suggested by the proposed structure for deoxyribonucleic acid (DNA) as two intertwined complementary molecular chains which uncoil and become templates for genetic replication. ¶ An answer to the key question of photosynthesis was proposed in a theory that energy packets released by chlorophyll strike the protogen molecule, breaking a bond tying the two sulfur atoms together; the energy is retained in the two resulting molecular fragments which then combine with other molecules to build proteins. ¶ Tests duplicating conditions that probably existed before life appeared on earth showed that chlorophyll could have been spontaneously created when two common gases and water were passed over heated silica. ¶ Chlorophyll was found to promote the release of water vapor from leaves in addition to its function in capturing energy from sunlight in the manufacture of food out of carbon dioxide and water. ¶ Debris of chromosomes left after the smashing of a virus have been photographed with the electron microscope. ¶ Algae can provide food high in protein and other necessary food elements suitable for human diet, it was found, giving promise of saving future populations from starvation. ¶ By labeling two bacterial viruses with radioactive phos-

phorus, it was found that the virus attacks its cell victim through chemical groups of atoms on the cell's surface. ¶ Chick embryos survived freezing in liquid nitrogen at  $-320^{\circ}$  F and thawing in tyrode solution. ¶ A new method was found for keeping cells alive inside a plastic incubator under a microscope while motion pictures were made. ¶ A coelacanth, survivor of a long-gone geologic age, and the third ever found, was caught off Madagascar. ¶ The San Benedicto Island wren was rendered extinct by the birth of a new volcano on the island. ¶ New birds, including babbler, lark, and warbler, were discovered in the Arabian Sultanate of Muscat and Oman. ¶ Genes are changed by mutation-causing agents but only indirectly through changes in the cell metabolism, it was found. ¶ Better varieties of many vegetables and flowers become possible through development of a sterile pollen method of producing hybrid seed. ¶ Brood X, biggest and widest-spread group of the periodical 17-yr cicadas, emerged for 6 wks of life spent in singing and in laying eggs that will hatch in 1970. ¶ Tiny black beetles of the family Nitidulidae were found to spread the fungus disease oak wilt from infected to healthy trees. ¶ A new antibiotic, oligomycin, was isolated and showed promise in the control of plant fungus diseases. ¶ A hydrocarbon insecticide 100 times as deadly as DDT yet nonpoisonous to man and domestic animals was developed. ¶ Study was begun on the long-neglected horseshoe crab, which has resisted evolutionary change for millions of years. ¶ Psittacosis, parrot fever, was found for the first time in turkeys. ¶ New rules were adopted to govern the scientific naming of animals; it is hoped that they will end the confusion between European and American practice. ¶ Australia's marsupials have been getting smaller since the Pleistocene age and the process is still going on, it was found.

#### *Chemistry and Physics*

A revision of Einstein's generalized theory of gravitation was published, a forward step toward finding a single theory to describe both gravitation and electromagnetism. ¶ Experimental proof was obtained for the Nernst-Einstein relation of the mobility of electrons and holes, important in transistor research. ¶ The spinor was suggested as the first arch of a possible bridge between Einstein's unified field theory and quantum concepts. ¶ A thermometer sensitive to the electrical noise generated by heat in a fine platinum wire was investigated for measuring high temperatures. ¶ Hard-to-detect strains in metals were spotted by measuring minute changes in spacing between their atoms as revealed by x-ray diffraction. ¶ Prediction was made of a new acousto-electric effect by which electrons are carried by sound when an acoustic wave passes a semiconductor. ¶ New information about the meson was promised by the discovery that this fundamental particle can originate in atomic collisions on only a few billion electron volt energies. ¶ Beams of mesons were used to measure the size of the atomic nucleus which was found to



be smaller by 15% than previously thought; a polarized proton beam was also used to study the nucleus. ¶ A 60,000-kw full-scale atomic reactor was designed to produce peace-time atomic energy. ¶ Bombardment of the earth with cosmic rays from outer space has not varied more than 10 to 20% over the last 35,000 yrs, it was concluded. ¶ A new charge exchange accelerator using protons as atomic projectiles was under development at the University of California and was dubbed the "swindletron" because it "cheats" by giving two boosts of energy to the projectile for each electric impulse. ¶ Plans were discussed for a 15-Bev "colossatron," a giant atomic accelerator using the new, strong-focusing principle developed last year. An electron synchrotron, which may later use the new strong-focusing system, started work at Cornell University. ¶ The beam of a 2,000,000-v atom smasher was pin-pointed so that it would strike only one or a very few of the genes in a living cell, contributing information on which parts of the cell would be most affected by radiation from an atom bomb. ¶ The possibility that the hydrogen bomb can be made without using the older fission-type atomic bomb as a trigger was speculated upon; a possible trigger was forecast in exploding wide experiments in the 1920's to duplicate the temperatures of the stars. ¶ The chemical structure of aureomycin, antibiotic drug, was discovered, making practical synthesis possible although highly improbable. ¶ Substances known as lysine polypeptides, which affect some viruses and bacteria in much the same way as the antibodies that create immunity, were synthesized. FAD, or flavin-adenine-dinucleotide, coenzyme essential to the utilization of oxygen, was synthesized. ¶ Catalase, an important plant and animal enzyme, may be a factor in the natural synthesis of both chlorophyll and hemoglobin, plant and animal research indicated. ¶ ACTH, pituitary gland hormone, was isolated as a pure white powder soluble in water and with a molecular weight of about 3500. ¶ An electronic device was developed, operating ultrasonically or in the audible range, to measure liquid flow including blood flow without use of surgery. ¶ A new way to separate small particles such as cells or bacteria which are of equal density but different electrical conductivity was found in their behavior in a magnetic field. ¶ Careful temperature control made possible the manufacture of germanium crystals uniformly enough to make transistors interchangeable. ¶ A sixth series of atomic spectrum lines, as well as the five previously known, was found in light given off by excited hydrogen atoms; the new series is in the infra-red part of the spectrum. ¶ When a cerium compound is dissolved in water and the solution set in sunlight, it was observed, two chemical reactions occurring in seesaw succession split the water into hydrogen and oxygen. ¶ Compounds of aluminum, gallium and indium with arsenic and antimony were found capable of acting as semiconductors and possibly as replacements for hard-to-get germanium. ¶ By separate studies of x-ray diffraction patterns and mathematical theory, new

understanding was reached of the structure of protein as a complex twisted form in which spring-shaped molecular chains are intertwined. ¶ Nine semi-living chemical substances known as enzymes were found to work in unison to permit the human digestion of fat. ¶ Radioactive cotton grown on a living cotton plant gave new evidence on how cellulose is formed. ¶ A whole new series of plastics was made possible from compounds of phosphorus, nitrogen, boron, and arsenic with other chemicals. ¶ A new synthetic rubber with resistance to aging due to oxidation and long wearing was made from the antifreeze fluids, propylene glycol and ethylene glycol mixed with adipic acid. ¶ A new food packaging material was made from a special type of saran which shrinks to fit the contents. ¶ Drying of paints, varnishes and inks was hastened by adding amine chemicals and metals to the linseed oil. ¶ A new chemical to protect foods from mold spoilage was announced as were two soy products that give bread a built-in fresh feel.

#### *Earth Sciences*

The greatest depth under the sea was reached when a descent was made to 10,339 ft off the island of Ponza, Italy, where complete blackness was found broken only by phosphorescent flickers. ¶ Granite rock from Manitoba was found to be  $3.5 \times 10^8$  yrs old, the oldest known; lead tetramethyl, made from radioactive lead, yielded the same figure. ¶ A hurricane's eye extends to the top of the storm and then comes back to earth in a second column of calm air 200 to 300 mi away called the "hyperbolic point"; tracking the hyperbolic point, it was reported, may permit better forecasting of the hurricane path. ¶ Cross-polarization of radar transmitting and receiving instruments made it possible to detect the presence of ice crystals in high clouds, thus providing additional clues relating to the occurrence of rain or snow. ¶ The process by which heat and pressure deep under the earth's crust deform rocks and cause them to flow was duplicated in the laboratory. ¶ Great internal waves, reaching a height of 300 ft but not rippling the surface, were found in the heart of ocean depths. ¶ The general level of the world's oceans was found to have risen 5 in. since 1895, due largely to melting polar ice. ¶ Dutch farm land, ruined by salt when floods broke the dykes and rushed over the land, was reclaimed by a process of ion exchange. ¶ A national water shortage was found to be due to greatly increased use and not to a general drop in water resources. ¶ Studies indicated that the earth's core is of solid iron surrounded by the same metal in a molten state, and that the temperature at the boundary between the two is a little greater than 8400° F; jet streams and swirling currents make motion of the core similar to that of the upper atmosphere. ¶ More than 500 tornadoes hit the United States, making 1953 a record year, the increase being attributed in part to improved observing and reporting programs. ¶ The first "mid-ocean" submarine canyon was discovered. ¶ Underwater television was successfully used to study fish life 100 ft below the surface

of a Canadian lake and the ocean bottom at a similar depth. ¶ Congressional action provided for the establishment of a committee to study the feasibility of rain making and other forms of weather modification. ¶ Powerful flashes of lightning were found to be associated with the growth of ice pellets or soft hail of thunderstorms. ¶ Large scale eddies cyclones and anticyclones were duplicated in laboratory models of the atmosphere, using both smoke in air and dyes in water. ¶ Preliminary studies of the formation of fog droplets indicated that the nuclei may be partly made up of tiny crystals of salt evaporated from the ocean. ¶ Measurements of electric charges on cloud droplets and the electric field of natural clouds suggested that the reason certain clouds produce rain and others remain unproductive may be related to electrification. ¶ Theoretical relationships between the vertical ascent of air and the rate of precipitation were developed into practical forecasting procedures. ¶ Numerical weather prediction by means of high-speed electronic computers achieved, for the first time, prediction of the development of an extra-tropical cyclonic storm; because of this success, the government established an operational numerical forecasting unit. ¶ A new seismograph capable of recording strong earthquake waves after they have circled the earth eight times went into operation and recorded Mantle Rayleigh waves, extremely long waves that may penetrate to the core of the earth and reveal its structure. ¶ A new, highly sensitive and speedy optical hygrometer, especially useful in below-freezing temperatures, was developed. ¶ Study of 50-yr records of the intensity of sunlight revealed information about the thickness of the ozone layer surrounding the earth. ¶ The rate with which stars twinkle may indicate where jet streams are and how fast they flow, it was suggested. ¶ Fluctuations in the Florida Current important branch of the Gulf Stream, were measured throughout the year by electromagnetic induction. ¶ Oceanographers found a heat flow from the ocean bottom equal to that from high and dry continents caused by radioactive elements. ¶ A new research tool, in the form of a bibliography of all the literature on the Arctic put out in the last 75 yrs, was made available.

#### *Engineering and Technology*

A tape recording system was developed for black and white and color television programs which permits immediate playback, can be wiped clean and reused, and costs much less than film recordings. ¶ "Project Tinkertoy" proved satisfactory; it is a program for putting radios, radars and electronic bombsights into mechanized production through use of standardized parts of printed circuits that can be assembled by machine. ¶ Progress toward entirely push-button factories included an electronic machine controlled by instructions on a magnetic tape, and an automatic eye operating in the infra-red to give a continuous analysis of liquid chemicals. ¶ Electronic machines to handle such clerical work as production scheduling and supply problems were under development. ¶ A mathe-

matical model of an electronic computer that reproduces itself was developed. ¶ A new type of "brain" utilized 10,000 tiny ring-shaped magnets woven into a netting of wires to serve as a memory to store 10,000 bits of information in an instant. ¶ A wrist radio using five transistors instead of vacuum tubes was produced; it picked up broadcasts 40 mi away. ¶ A 400-kv transmission line was successfully used to transmit hydroelectric power over a 600-mi distance in Sweden; this is a record high operational transmission voltage level. ¶ Development continued on unusual ceramic materials needed by the Atomic Energy Commission to withstand the harmful effects of atomic radiation and extraordinary high temperatures. ¶ Some half dozen catalyst beads impregnated with radioactive zirconium were used routinely to indicate the circulation rate of billions (tons) of catalyst beads in several gasoline cracking refineries. ¶ An experimental plant went into operation to extract aluminum metal from common clays; the idea is to make this country independent of imported bauxite as an aluminum source. ¶ A specially built camera making exposures of from 1 to 10  $\mu$ sec was used to photograph tiny dirt and moisture particles in the air. ¶ Silicone rubber was used successfully for electric wire insulation, standing up under extremes of heat and cold. ¶ A three-dimensional technique was developed for making photomicrographs. ¶ An electric power generator with turbine was designed to be powered by steam above the critical pressure. ¶ Water was pumped into the subsoil of Mexico City by rehydration wells to restore the water supply of the city and stop its sinking into the ground. ¶ Small gobs of air, called "dielectric" eddies, in the atmosphere were found to disrupt television transmission in fringe areas. ¶ Television waves and other very high frequency signals were found to be bent around mountains by diffraction to continue along a long path on the other side of the obstacle. ¶ A wire rope with a plastic core unaffected by acids, caustics and other sub-surface substances was developed for use in drilling oil and gas wells. ¶ Magnesium was used in lightweight automobile bodies and found to be better than plastic. ¶ An electromagnetic "divining rod" was developed to locate underground water sources. ¶ A new method of reproducing maps by line-scribing on an opaque emulsion applied to plastic sheeting was reported. ¶ An aerial estimator, a device resembling a reflector-type gunsight, was developed to help in estimating the size of forest fires, timber stands, lakes, etc. ¶ A fluorescent lamp with quartz inner tube was found to give about 2.5 times more light than an incandescent lamp of equal power and lasts about five times longer. ¶ A method was found for working 16-Alfenol, heretofore an unusable magnetic curiosity. ¶ A new coaxial telephone cable system was installed between New York and Philadelphia to carry simultaneously 1800 separate conversations. ¶ Use of radioactive tracers to label the oil intended for various destinations enabled the operator at any point along the pipe-line to draw off just the batch intended for him. ¶ Two new types of transistors, "tetrodes" and "pentodes," were announced; they have three and four



wires, respectively, instead of two. ¶ Crystals of barium titanate were found capable of "memorizing" answers to 250 questions and producing them on demand in the form of positive or negative electric charges. ¶ A large experimental transistor has been produced that is capable of handling 20 watts of output power. ¶ A telephonic robot device was developed that "listens" to clearly enunciated digits, then matches the sound pattern electronically to standard referents stored in its memory, and responds by flashing an appropriate light.

#### Medical Sciences

Plans were announced for a large-scale field trial, starting in Feb. 1954, and involving at least 500,000 second grade children, of a vaccine against all three types of poliomyelitis. ¶ Gamma globulin from blood was given widely to children in many regions in hope of preventing paralysis from poliomyelitis, following reported successful field trials of it in the 1952 season. ¶ Electron microscope pictures and measurements of the poliomyelitis virus were made, showing it to be sphere-shaped and about  $10^{-6}$  in. in diameter. ¶ Discoveries of a new virus, called Mack virus, which can cause a polio-like disease, and of another virus, called Kentucky virus, which may be a fourth type of polio virus, were announced. ¶ The third of the three known strains of polio virus was adapted to growth in laboratory mice. ¶ Synthesis of oxytocin, first pituitary gland hormone to be synthesized, was announced with the hint that synthesis of another pituitary hormone, vasopressin, was almost accomplished. ¶ Growth hormone from the pituitary gland and thyroxine from the thyroid were reported responsible for tooth growth and eruption. ¶ Essential fatty acids from fat in the diet were reported effective in protecting laboratory rats from critical doses of x-rays similar to atomic bomb radiation. ¶ First report of study of first generation of children born to parents who survived atomic bombing in Hiroshima and Nagasaki showed no bad effects of significance with only slight increase in stillbirths and births of malformed babies. ¶ Study of sexual behavior of 5940 white women showed, among other things and for the group studied, though there were wide individual variations, that females become sexually responsive later and remain so to an older age than men, are affected by fewer and different psychological factors than men, are more faithful when married than men, are more successful in marriage when prepared by premarital sexual experience, and are less "frigid" in marriage if born after 1900 than before. ¶ Research suggested patients with multiple sclerosis might be helped by a diet low in fat, particularly if started early in the course of the disease. ¶ Treatment to raise blood pressure and stimulate circulation was advised for multiple sclerosis patients in a report showing two-thirds of all early, microscopically small multiple sclerosis damage spots located close to blood vessels, and that more than half of 250 patients had markedly low blood pressure. ¶ More people have multiple sclerosis and there are

more deaths from the disease in Canada and the northern states than the south, a geographic survey showed. ¶ A chick embryo method for cutting time to diagnose tuberculosis from weeks to days was announced. ¶ A new drug promising to help streptomycin in treatment of tuberculosis called HES, or hydroxyethyl sulfone, was synthesized. ¶ A new anti-tuberculosis vaccine was made from urea-killed virulent human tubercle bacilli. ¶ A chemical in the body, lysozyme, was found important in resistance to tuberculosis. ¶ Evidence was found that the growth hormone from the pituitary gland may be the cause of arthritis. ¶ Cortisone, anti-arthritis adrenal gland hormone, was reported effective antidote for yellow phosphorus poisoning. ¶ One form of anti-anemia vitamin  $B_{12}$ , hydroxo-cobalamin, was found in mice to act as swift antidote to cyanide poisoning. ¶ Formation of disease-fighting antibodies was found to depend in part at least on getting in the diet plenty of these vitamins: pantothenic acid, folic acid and pyridoxine. ¶ Examination of white blood cells for lymphocytes with two-lobed nuclei was reported a practical, sensitive test for exposure to very small amounts of atomic radiation from cyclotrons. ¶ Hemophilia, heretofore thought only a male disease, was found to occur in females also. ¶ Atherosclerosis was produced for the first time in monkeys by a special diet, giving scientists an animal that eats human-type food for further research on the disease. ¶ Cortisone was reported to have saved 75% of babies from Rh blood deaths. ¶ Radioactive cortisone and hydrocortisone were made with carbon 14. ¶ Discovery of a link between anti-anemia vitamin  $B_{12}$  and diabetes, particularly diabetic blindness, gave further evidence for the vitamin being involved in the body's handling of fat and carbohydrates. ¶ Plasminogen, newly isolated fraction of human blood, was found capable of dissolving dangerous blood clots in veins. ¶ A blood pressure lowering chemical, andromedotoxin, was discovered in rhododendron leaves. ¶ A parasite called toxoplasma was announced as probable cause of widespread eye infections. ¶ Irradiation of pork with cobalt 60 was reported effective for killing trichina. ¶ A treatment with 22 amino acids and selected vitamins was reported helpful in muscular dystrophy. ¶ Discovery that there are groups and types of blood platelets as well as of red blood cells was announced. ¶ Discovery of the tissue network that connects teeth to gums was announced. ¶ Adrenalin production starts before birth, perhaps helping prevent prebirth or birth asphyxiation, studies of unborn lambs showed. ¶ A new drug for ulcer patients, a quaternary ammonium compound akin to so-called soapless soaps, went on the market. ¶ Methoxamine hydrochloride, a synthetic drug, was found effective for treating excessively rapid heart beating. ¶ Discovery was announced of an abnormal adrenal hormone, 17 $\alpha$ -hydroxypregnanolone, in arthritis patients. ¶ A new adrenal gland stimulating hormone from the pituitary, called AGF and distinct from ACTH, was discovered. ¶ A drug to eliminate excess water, sodium and potassium from water-logged tissues of patients with congestive heart

failure was made from sulfanilamide. ¶ An artery crushing operation was found to relieve rigidity and involuntary movements of Parkinsonism. ¶ The digestive enzyme, trypsin, was found capable of dissolving life-threatening clots in the heart's arteries and, in aerosol form, of helping asthma patients. ¶ A synthetic drug that stops coughing without addiction or pain-relieving properties was found in the dextro isomer of the synthetic pain-killer, Dromoran. ¶ A new synthetic hormone drug, androstanolone, with weak masculinizing effects, was reported helpful to women with advanced inoperable breast cancer. ¶ Radioactive gold wire encased in nonactive gold tubing was developed as a safer and more advantageous treatment for cancer than the use of radium seeds. ¶ A fatty substance from small intestines of mice and rats was found to destroy cancer cells in test tube leaving normal cells unharmed. ¶ Hormone production of the mother's glands during pregnancy was reported possibly causing predisposition to some kinds of cancers. ¶ Three-dimensional x-ray pictures were made using synchronously moving x-ray tube and subject. ¶ An electric stimulus across the chest was made to act as sole "pacemaker" to keep a stopped heart beating for five days when it started on its own again.

#### *Psychiatry and Psychology*

For the first time a research team went into the combat area and obtained measures of the physical and mental consequences of combat stress; important effects were found to be dehydration and a serious reduction in adult white blood cells. ¶ The chemical process involved in night vision was duplicated in the laboratory and one of the chemicals involved for daylight vision, cyanopsin, was produced from an extract of dark-adapted rods and the cones from chicken eye retinas. ¶ Several objective tests were found to be promising for the measurement of temperament, including a color film to test for the dominance of form over color perception or the reverse. ¶ Individuals can learn to recognize at least 10,000 distinct odors and can detect fantastically tenuous odors, it was found, but they are quite poor at distinguishing slight differences in intensity of smells. ¶ Two kinds of pain, pricking and burning, follow the same nerve pathways to the brain, it was determined; a finding important to surgeons performing nerve-blocking operations to relieve intractable pain. ¶ The part of the brain that controls appetite was located in the hypothalamus at the base of the brain. ¶ Individuals with high scores on intelligence tests do even better as they grow older, retesting after an interval of 30 yrs indicated. ¶ Little boys should be six months older when they start school than are little girls, tests of maturity on children indicated; this would save about 2% on the cost of education. ¶ Follow-up study of individuals who as children were placed in "opportunity rooms" for mental deficiency, showed they make a much better adjustment to life than has been supposed and their children, if any, go through school with little or no retardation. ¶ An Institute of Human Variation was established to

study what biological and social factors are responsible for producing differences between individuals. ¶ Few people act strictly according to their own prejudices, and many people live in a remarkably strict self-imposed segregation from other groups; these were preliminary findings of an eight-year study of intergroup relations. ¶ Mice defeated repeatedly in fights with other mice developed "combat fatigue," a finding promising that these animals may be used to throw light on the causes of combat breakdown in humans. ¶ A method was devised for recording the brain waves of a patient and a motion picture of his movements on the same film. ¶ Jerky eye movements reveal when a sleeping person is dreaming, it was observed. ¶ Flashing lights in the eyes and semicarbazide, a drug related to isoniazid, new TB drug, were successfully used to produce convulsions for the shock treatment of schizophrenia. ¶ An elixir of metrazol was found to produce improvement in aged mental patients.

#### **Grants and Fellowships**

The AiResearch Manufacturing Company, a division of the Garrett Corporation, Los Angeles, has established a \$56,000 fund for the support of teaching and research in the history of science at the **California Institute of Technology**. The fund will make possible two innovations at the Institute: a general course in the history of science, and a research project in the history of flight under pressurized conditions, such as those which prevail on any flight at high altitude. Rodman W. Paul, professor of history, will direct the three-year program which the new fund will support. Thomas M. Smith, newly-appointed assistant professor of the history of science, will conduct the study and write the history as well as teach the new course when it is introduced next year.

The **American Heart Association**, 44 E. 23rd St., N.Y.C., has announced that entries for the second annual Howard W. Blakeslee Award for outstanding scientific reporting in the field of heart and blood vessel diseases *must be submitted by Jan. 15, 1954*. The award, in the amount of \$1000, will be presented at the Association's Annual Dinner early in 1954 to the individual whose creative efforts in any medium of mass communication are judged to have contributed most to public understanding of heart and circulatory diseases.

The **General Electric Educational and Charitable Fund** has announced that *until Jan. 15* it will accept applications from college graduates for research grants to continue their studies next year in the physical sciences, engineering, and industrial management. Under this program, married students receive \$2100 and unmarried ones \$1400 for living expenses. The educational institutions they will attend will get a grant of \$1200 for each fellowship holder to cover tuition and related costs.

The **John and Mary R. Markle Foundation** has ap-

pointed the following Scholars in Medical Science for 1953:

W. G. Anlyan, Duke University.  
M. B. Carpenter, College of Physicians and Surgeons, Columbia University.  
B. Childs, The Johns Hopkins University.  
J. Davies, State University of Iowa.  
H. F. Elchenwald, Cornell University Medical College.  
M. M. Figley, University of Michigan.  
B. Fisher, University of Pittsburgh.  
R. S. Fraser, University of Alberta.  
W. L. Henry, Jr., Howard University.  
W. S. Jordan, Jr., Western Reserve University.  
R. C. Jung, Tulane University.  
C. F. Kittle, University of Kansas.  
J. C. Laidlaw, University of Toronto.  
G. D. Ludwig, University of Pennsylvania.  
J. B. McCriston, McGill University.  
T. H. Noehren, University of Buffalo.  
R. W. Noyes, Stanford University.  
C. N. Peiss, St. Louis University.  
G. D. Penick, University of North Carolina.  
W. F. Scherer, University of Minnesota.  
D. P. Shedd, Yale University.

## Meetings and Elections

With the chartering of Arizona's first local section of the **American Chemical Society**, the Society now has sections in every state of the Union. The new group, known as the Southern Arizona Section, will have headquarters at Tucson and will serve chemists and chemical engineers of six counties: Cochise, Gila, Graham, Maricopa, Pima, and Pinal. This section, comprising 84 charter members, becomes the 144th local unit of the Society, which has more than 70,000 members.

The **American Microscopical Society** has elected the following officers for 1954: pres., Oscar W. Richards, American Optical Co., Southbridge, Mass.; 1st v. pres., R. P. Hall, New York University; 2nd v. pres., Robert W. Pennak, University of Colorado; sec., C. J. D. Brown, Montana State College, Bozeman, Mont.; treas., Frank F. Hooper, University of Michigan.

The Pan American Medical Association, a 26-year old organization that brings together leaders in all branches of medicine and public health, has announced its **Ninth Inter-American Medical Congress**. More than 2500 physicians and medical researchers from 22 nations of the Western Hemisphere will exchange information on the latest developments in medicine, surgery, and related fields during a 16-day medical congress to be held in six Latin American cities and aboard ship enroute to these ports. On Jan. 6 more than 700 U.S. physicians and their families and associates will sail from New York to the conference.

The American Psychological Association has announced the formation of a new scientific group, the **Society of Correctional Psychologists**, which is composed of clinical psychologists attached to prisons, reformatories, and other correctional institutions. The society will be a part of the Association's Division 18, a division for psychologists in public service. It is estimated that there are over 150 psychologists working on parole, probation, and prison problems, both

civilian and military, who are eligible to join the new organization.

Arnold V. Goulding, clinical psychologist at Auburn Prison, N.Y., has been elected president and the other officers are as follows: 1st v. pres., Capt. William R. Perl, USA, Fort Leavenworth Disciplinary Barracks, Kan.; 2nd v. pres., John Adams, House of Correction, Jessups, Md.; sec.-treas., Sheldon Peizer, Ohio State Reformatory, Mansfield.

The Chicago Section of the Instrument Society of America has arranged a two-day **Symposium on Methods of Instrumental Analysis** for Feb. 1-2, 1954. Papers have been scheduled on the following subjects: measurement of pH; measurement of solution conductivity; amperometric analysis and polarography; colorimetry, nephelometry, and photofluorimetry; infra-red analysis and spectrophotometry; spectrophotometry in the visible and ultraviolet; optical polarimetry and saccharimetry; and electrophoresis (tentative).

The material to be presented is to deal with principles and methods rather than with equipment. Errors, their causes, their prevention, and methods of checking will be emphasized. The symposium is directed at the group-leader level, and should be of interest to research workers, supervisors, and to group leaders in general.

It is planned that complete printed proceedings be available to every registrant at the time of the symposium. To defray the cost of preparing these, a registration fee will be charged. Advance registration is requested whenever possible. Registration may be made either through George R. Kincaid, Beckman Instruments, 7145 W. Belmont Ave., Chicago 34, Ill., or with Prof. H. C. Roberts, 511 W. Washington St., Urbana, Ill.

The University of Texas Medical Branch, Galveston, was host to the **Texas Academy of Science** at its annual meeting, Dec. 4-5, 1953. The meeting included special sessions for the collegiate academy and the Junior Academy. A feature of the meeting was a series of tours and field trips covering bird watching, marine life, beach collecting, and geologic features. The meeting was under the presidency of D. Bailey Calvin of the University of Texas Medical Branch, with John C. Finerty acting as chairman of the local committee on arrangement. J. P. Harris, Jr., of Southern Methodist University, was elected president for next year. Special sections were held in meteorology, physical and earth sciences, oceanography and marinology, chemistry and engineering, zoology, botany, social sciences, earth sciences, and conservation. A feature of the program was a symposium on "Collegiate Training in the Fundamentals of Science," with Charles M. Pomerat, Director of the Tissue Culture Laboratory of the University of Texas Medical Branch, as moderator. The Medical Branch buildings contained a series of exhibits arranged particularly for academy members.

# Technical Papers

## Failure of Mercaptoethylamine to Protect against the Mutagenic Effects of Radiation I: Experiments with *Drosophila*

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The work of Baq and Herve (1) has shown that  $\beta$ -mercaptoethylamine ( $\text{SH}-\text{CH}_2-\text{CH}_2-\text{NH}_2$ ) affords protection against the lethal effects of radiation and produces a marked decrease in mortality when administered intraperitoneally to mice during the half-hour preceding whole body irradiation. However, Baq and Herve did not determine whether this substance also protects against the mutagenic effects of radiation. Accordingly, upon the suggestion of Baq, the possibility of its being an antimutagen was tested in small scale experiments using *Drosophila melanogaster* and mice as the test organisms. Consistently negative results were obtained.

In the *Drosophila* experiments 3 groups of day-old adult wild-type males were used. Flies of groups A and C had injected into their abdomens a solution of Labaz  $\beta$ -mercaptoethylamine diluted to a final concentration of 1/1000 in 0.75% sodium chloride. The quantity of fluid injected, 0.2-0.3 mm<sup>3</sup>, was sufficient noticeably to distend the abdomens of the flies. Each fly, therefore, received approximately 0.25% of mercaptoethylamine. This amount was somewhat more per unit body weight of fly than the amount injected per unit body weight of mouse in Baq's work. Group B was injected with 0.75% sodium chloride. Groups A and B were irradiated simultaneously and received 2400 r of x-radiation (70 kv, 7 ma; filter 0.5 mm Al; H.V.L. 0.8 mm Al; 165 r/min) approximately 15 min after the injections. Group C was not irradiated. Determinations of dominant and sex-linked recessive lethals were performed on all three groups.

Dominant lethality is defined as (1-hatchability). To measure it males of Groups A, B, and C were mated to virgin Muller-5 females, the eggs were collected, and the hatchability determined. Ten males from each group were used and pair matings were set up, each male being kept with the female for 3 days, then being presented with a fresh virgin female for a second period of 3 days. Hatchability was measured for each 3-day period. Thus, data were obtained from 2 broods, the male gametes producing the 2nd brood having been treated at an earlier stage of spermatogenesis than the gametes of the 1st brood. Table 1 summarizes these data. The results with the nonirradiated group C indicate that mercaptoethylamine, by itself, has no significant effect upon hatch-

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TABLE 1  
HATCHABILITY OF EGGS LAID BY FEMALES MATED TO TREATED *Drosophila* MALES

Group and treatment*	Brood 1		Brood 2	
	Total eggs laid	Hatchability %	Total eggs laid	Hatchability %
Group A (I + R)*	144	37.5	138	13.3
Group B (R)	211	35.0	275	16.7
Group C (I)	227	91.6	93	93.5

\* I, injected with mercaptoethylamine; R, irradiated.

ability, the figures obtained being within the standard hatchability range of the stock used. Among the irradiated males there was no significant difference between the saline-injected group (B) and the amine-injected one (A). In both groups there was a sharp decrease in hatchability (increase in dominant lethals) and a falling off in fertility between the 1st and 2nd broods. This marked parallelism between groups A and B indicates that the amine was not able to modify the combination of effects, exerted by x-radiation, which are measured by hatchability determinations.

For the determination of sex-linked recessive lethals mass matings were set up. Three broods were derived from each of the 3 groups of males by presenting 25 males of each group with 3 successive sets of virgin Muller-5 females, each for a 3-day period. Thereafter, at the end of each period, the standard Muller-5 test for sex-linked lethals was carried through. Thus, germ cells were sampled which were at 3 different stages of spermatogenesis at the time of irradiation. Table 2 summarizes the results obtained. The Brood 1 data clearly indicate that mercaptoethylamine had no antimutagenic action. The results from subsequent broods are of greater theoretical interest, since it is within these broods that the results of an indirect or secondary effect of x-rays upon the mutation rate might be brought to light. It might be supposed that in the maturing germ cells x-rays interfere with one metabolic process or another and so result, ultimately, in the presence of mutations.

TABLE 2  
FREQUENCY OF SEX-LINKED RECESSIVE LETHALS AMONG THE OFFSPRING OF TREATED *Drosophila* MALES

Group and treatment*	Brood 1		Brood 2		Brood 3	
	a†	b‡	a†	b‡	a†	b‡
Group A (I + R)*	320	8.4	42	12.0	142	3.5
Group B (R)	348	8.5	137	11.7	188	1.6
Group C (I)	418	0.2	263	0	330	0

\* I, injected with mercaptoethylamine; R, irradiated.

† Total chromosomes counted.

‡ Percent lethals.



It is precisely upon such a process that an anti-mutagen might be expected to act. However, no reduction of the mutagenic activity of x-radiation was revealed by the methods used. The number of chromosomes tested was, however, small in Brood 2. This was due to the marked decrease in fertility which characteristically occurs in later broods following irradiation of adult males (2). Nevertheless, despite the extreme smallness of the sample, the similarity of groups A and B, both in the frequency of sex-linked recessive lethals and in the falling off of fertility, indicates that if mercaptoethylamine has any influence upon the genetic effects of x-radiation in *D. melanogaster*, it cannot be measured by the techniques employed. It did not, therefore, seem worth while to continue the work on a larger scale.

The data derived from group C and listed in Table 2 show that, by itself, this amine is not a mutagen. The spontaneous sex-linked recessive mutation rate for this stock is 0.3%.

An attempt was also made to determine whether mercaptoethylamine protects *Drosophila* against the lethal somatic effects of radiation. Two groups of flies, mercaptoethylamine-injected and controls, were each given 82,000 r in 41 min, but at this dose both groups survived. It was not possible to carry this investigation further.

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Manuscript received September 21, 1953.

## Failure of Mercaptoethylamine to Protect against the Mutagenic Effects of Radiation II: Experiments with Mice

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The negative results obtained using *Drosophila melanogaster* as the experimental animal did not, by themselves, rule out the possibility that  $\beta$ -mercaptoethylamine might possess antimutagenic properties. Two possible explanations of the results obtained are its inability effectively to reach the germ cells, and its very rapid destruction by the tissue fluids of the insect. Consequently, it was decided to carry out a test for antimutagenicity in mice, where the protective action against the lethal somatic effects of x-radiation has been so clearly demonstrated by Bacq and Herve.

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<sup>3</sup> We are grateful to R. McWhirter for permission for some of the irradiations to be carried out in the Radiotherapy Department, Royal Infirmary, Edinburgh, and to C. A. Murlison for performing them.

To this end male mice were irradiated with 500 r of x-radiation. After such a dose there is first a period of reduced fertility and then a period of complete sterility followed by a return to normal fertility. Snell (1) has shown that the reduced fertility immediately after irradiation is largely due to dominant lethals which cause the death of embryos soon after implantation. The proportion of implanted embryos which were inviable was therefore taken as a measure of dominant lethality in the present experiment. The effects of mercaptoethylamine on both the induction of dominant lethals and the onset of complete sterility were examined.

Two groups of 6 CBA inbred mice were used. Both groups of males received 500 r of x-radiation (70 kv, 7 ma; filter 0.5 mm Al; H.V.L. 0.8 mm Al; 165 r/min) while under Nembutal anesthesia (10% Nembutal in Ringer's solution, 0.1 ml per 10 g body weight, injected intraperitoneally). One group received in addition an intraperitoneal injection of 4 mg mercaptoethylamine in Ringer's solution, given after the onset of anesthesia but before irradiation. The control group received no such injection. The time interval between the mercaptoethylamine injection and irradiation was 4-7 min. The mice were irradiated individually and only the hindquarters and scrotum were exposed.

Directly after treatment each male of the control and experimental groups was placed in a cage with 5 normal females and remained there for 10 days. Thereafter, 3 more batches, each of 5 females, were presented to each male for 3 further 10-day periods. The presence of a vaginal plug was taken as an indication that mating had occurred. In addition, some pregnancies were detected by the "placental sign" (2) although no vaginal plug had been seen. The females were killed after 12-14 days gestation, the uteri opened, and the numbers of live and dead embryos and of corpora lutea determined. From these data 3 ratios were calculated:

$$\frac{\text{Number of live embryos}}{\text{Total number of embryos implanted}} \quad (1)$$

This ratio is equivalent to the hatchability measurements in the *Drosophila* experiments (Table 1a).

$$\frac{\text{Total number of embryos}}{\text{Number of corpora lutea}} \quad (2)$$

This ratio indicates the proportion of successfully implanted ova out of the total number shed (Table 1b).

$$\frac{\text{Number of pregnancies}}{\text{Number of vaginal plugs observed}} \quad (3)$$

This ratio serves as an indication of the fertility of the male (Table 1c). (Pregnancies which were detected without the finding of a vaginal plug were not included in this tabulation.)

Table 1a records the embryo viability within the four 10-day mating periods for the controls and mercaptoethylamine-treated males. The differences between the 2 groups, for any one period, are not statistically significant. Thus, the amine had no de-

TABLE 1  
OBSERVATIONS ON THE OFFSPRING Sired BY IRRADIATED MALE MICE

Treatment of male	Period								Total	
	1		2		3		4			
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>a. Ratio of Live to Total Embryos*</i>										
Control (R)†	41/67	61.2	37/80	46.3	27/47	57.4	1/1	—	106/195	54.4
Mercaptoethylamine (I + R)	62/105	59.0	35/85	41.2	15/18	83.3	1/2	—	113/210	53.8
<i>b. Ratio of Total Embryos to Corpora Lutea</i>										
Control (R)	67/91	73.6	84/103	81.6	47/69	68.1	1/9	—	199/272	73.2
Mercaptoethylamine (I + R)	97/126	77.0	81/101	80.2	18/38	47.4	2/7	—	198/272	72.8
<i>c. Ratio of Pregnancies to Vaginal Plugs Seen</i>										
Control (R)	6/11	—	6/9	—	7/13	—	0/14	—		
Mercaptoethylamine (I + R)	13/14	—	10/14	—	4/14	—	1/9	—		

\* Small discrepancies in total numbers of embryos between a and b were due to the exclusion of 1 or 2 litters in which the number of corpora lutea or viability of particular embryos were in doubt.

† I, injected with mercaptoethylamine; R, irradiated.

monstrable influence upon the induction of dominant lethals by the radiation.

Tables 1a and 1b show further that between the 2nd and 3rd periods there was a marked falling off in the total number of embryos in both the control and the amine-injected groups. The 4th period was one of almost complete sterility. Table 1c shows that the proportion of fertile matings fell off similarly. These findings agree with Hertwig's (3) histological study which showed that spermatogonia were almost entirely destroyed by a comparable dose of radiation, resulting in a complete lack of mature sperm after an interval of a few weeks. In none of these tables is there any significant difference in fertility between the control and treated males. This clearly shows that male germ cells were not afforded any protection by mercaptoethylamine against radiation death.

After the end of the 4th mating period several males from the treated and control groups were killed, their testes fixed and sectioned, and subsequently compared, histologically, with those of nontreated males. The testes from the 2 x-rayed groups were similar but differed from those that had received no radiation chiefly in the relative numbers of mature spermatozoa and spermatids. In the latter case there were many mature sperm cells and spermatids in various stages of spermiogenesis, whereas in the former case there was only a small number of mature or maturing sperm. There were no obvious differences in the relative numbers of spermatogonia and spermatocytes in the seminiferous tubules of the 3 groups of testes. This picture indicates that the period of sterility was approaching its end. However, the histological picture strengthens the genetic results in indicating that the mercaptoethylamine had no effect in protecting the germ cells against radiation.

The combined *Drosophila* and mouse studies clearly

indicate that mercaptoethylamine has no influence upon the genetic effects of radiation as measured in these experiments; nor does it protect the male germ cells against radiation death. These findings are thus in line with the more recent work of Bacq and his colleagues (4) suggesting that mercaptoethylamine exerts its protective action through the liver and that the primary effects of radiation on other organs are not prevented.

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Manuscript received September 21, 1953.

#### Preparation of High-Purity Lithium Metal by Vacuum Distillation

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In connection with the stable isotope program of this laboratory, measurements of physical properties of isotopically pure, or nearly pure, isotopes and their compounds are being carried out to determine possible significant differences in their values. For example, as a result of mass difference, there may be some variations in melting points and boiling points of the isotopes. For dependable values, however, it is also necessary to have high chemical purity.

<sup>1</sup> This paper is based on work performed for the AEC by Carbide and Carbon Chemicals Co., a Division of Union Carbide and Carbon Corp., at the Oak Ridge National Laboratory.



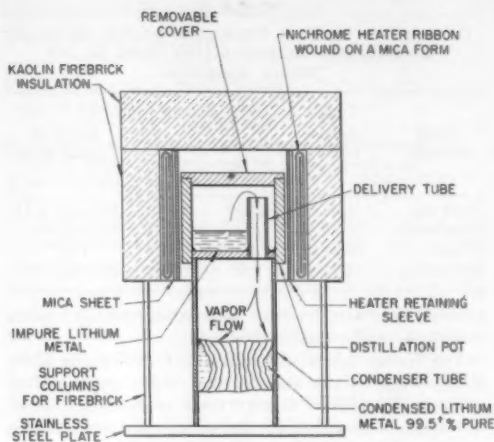


FIG. 1. Distillation unit.

Since the lithium nuclides are available (1), and furthermore, because any difference in properties should be enhanced in the case of lithium on account of the relatively large mass difference between its isotopes, they were investigated first. But the methods used for small-scale reduction of lithium compounds to the metal leave considerable impurities, so that some sort of purification is necessary.

Commercially, metallic lithium is purified on a large scale by distillation (2). Epstein and Howland have reported preparation of small quantities of high-purity metal by vacuum distillation in glass (3). Rogers and Viens distilled the metal in a 5-ft-long steel retort (4).

The apparatus described here is much smaller than either that of Rogers and Viens or the commercial arrangement, it does not require the "cold finger" of Epstein and Howland, yet it is quite simple and efficient. The unit consists of a "pot" made of 17/8-in. OD stainless steel tubing with 5/32-in. wall thickness, a removable cover, and a delivery tube—all resting on a "condenser" of 1 1/2-in. stainless tubing of 1/16-in. wall thickness which is placed on a stainless steel plate. Heating is accomplished with a suitable length of 1/8-in. nichrome resistance ribbon wrapped around



FIG. 2. Vacuum system.

mica sheet which, in turn, is coiled around a sleeve of stainless steel shim stock and insulated thermally by fire brick. The arrangement, as shown in Fig. 1, is enclosed in the Pyrex vacuum system shown in Fig. 2. Although many of the distillations were carried out with the 3 x 6 in. Pyrex glass reducer, the tendency of the glass to crack under the strain which developed while tightening nuts to seal the system led finally to the substitution of a 4 x 6 in. black iron, flanged reducer. Both types of reducers were capped at the ends with flanges and gaskets which accommodated the vacuum line, the leads from the power supply, and leads for the thermocouple. The temperature of distillation is about 500° C, although this can be varied to suit the sample.

The efficiency of the process is shown by typical data given in Table 1. Separation is poor where strontium is an impurity, since the vapor pressure curves for lithium and strontium are so nearly alike (5). Otherwise, with a 5-g charge of material with 2 or 3% impurities, the yield of 99.5+ % metal is 60-70% of the charge in about 4 hr when the pressure is 0.05

TABLE 1

Constituent	Run No. 1*		Run No. 2*		Run No. 3†		Run No. 4†	
	Initial %	Final %	Initial %	Final %	Initial %	Final %	Initial %	Final %
Al	> 1	T‡	> 1	ND	ND	ND	ND	T
Ba	ND‡	T	ND	ND	0.03	T	0.03	T
Ca	0.05	T	0.05	T	0.5	T	0.5	T
Mg	T	T	T	T	0.3	T	0.3	0.05
Na	0.5	< 0.05	0.5	< 0.05	0.1	≈ 0.05	0.1	≈ 0.05
Si	0.1	T	0.1	T	ND	ND	ND	ND
Sr	ND	ND	ND	ND	> 1	1	> 1	0.5

\* Electrolytically reduced metal.  
† Thermally reduced metal.

‡ T = trace (< 0.02%).  
§ ND = not detected.

micron. The constituents with higher vapor pressures than lithium are deposited beyond the lithium, and those with lower vapor pressures than lithium are either deposited before it or remain with the undistilled charge material.

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Manuscript received September 23, 1953.

## Differential Dietary Choices of Albino Rats Occasioned by Swimming<sup>1</sup>

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Claude Bernard (1) first enunciated the principle of the constant internal environment. Later Cannon (2) extended the concept in the field of physiology and spoke of the steady state, or homeostasis.

Richter (3) was the first to employ the concept of homeostasis in the area of behavior when he and his associates reported that rats were able to grow and thrive on a self-selected diet containing as many as 15 purified foodstuffs. Richter (4) also reported that when particular "part-regulators" of body balance were removed, such as the adrenal glands, the total organism through its behavior in a free dietary choice situation would compensate for the loss of the "part-regulators" and, in the case mentioned, would consume excessive amounts of sodium chloride and thus remain alive in spite of bilateral adrenalectomy. Similar observations on increased calcium and decreased phosphorus intakes of parathyroid-ectomized rats have been interpreted homeostatically by Richter and Eckert (5). Pancreatetomized rats were found to ingest large amounts of water and to select fats and protein and refuse carbohydrate, thus losing the symptoms of diabetes (6). From these and similar studies (7, 8), Richter and his associates concluded that behavior itself could act as a homeostatic mechanism for the total organism.

The present study was designed to investigate further the concept of homeostasis at the level of the total organism, the behavioral level. Specifically, we were interested to determine whether, after swimming in a tank of water until symptoms of exhaustion were

<sup>1</sup> Supported in part by a grant-in-aid from the Research and Development Board, Department of the Army, Contract No. DA-49-007-MD-271, and in part by the Graduate School of the University of Mississippi. The opinions expressed are those of the authors and are not necessarily held by any branch of the Armed Services.

TABLE 1  
COMPARISONS OF FOOD SELECTIONS OF TEN RATS ON  
MODIFIED SELF-SELECTION DIET PRIOR TO AND  
DURING SWIMMING

Food element	Av. intake during rest	Av. intake during swimming, cc	t	Level of significance
Dextrose	3.69 cc	43.00	11.30	Beyond 0.1%
Saccharine	3.46 cc	2.40	0.31	Not signif.
Water	20.53 cc	6.71	3.97	1%
McCollum	12.74 g	5.02	2.22	Not signif.

evident, rats would choose between calorically useless saccharine and valuable dextrose.

Ten Wistar inbred male albino rats, averaging 250 g body weight at the start of the study, were used as subjects. The diet of this group, a modified self-selection type, consisted of the following: in solution form—20% solution of dextrose, 0.15% solution of saccharine distilled water; in solid form—McCollum stock diet. The solutions were presented in 100-ml graduated inverted bottles affixed to specially constructed living cages. The solid was available in a nonspillable food cup placed within the living cage. The positions of the solutions were switched in a random manner to prevent establishment of position habits. Daily records were kept on the quality and quantity of dietary choices during an 8-day "rest period." Following this period was a 14-day interval during which the animals were swum daily in an inverted glass bell jar containing moderately warm water for an average of 1 hr 50 min, or until distress was evident.

Table 1 shows the average daily dietary selections of the 10 subjects during the 8-day rest period and the 14-day swimming period.

The data treated statistically, using the F and T tests, indicate that significantly more dextrose was consumed during the swimming period in comparison with the rest period. No significant differences were found in the amounts of saccharine and McCollum diet chosen during the two periods.

The results of this study make it apparent that rats will alter their dietary selections in relation to the requirements of the situation. They tend to prefer a calorically valuable substance to a similar tasting but calorically useless substance when forced to expend energy.

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Manuscript received October 26, 1953.

## Fractions of Human Milk and Virus Multiplication<sup>1</sup>

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Human milk contains growth-promoting factors for *Lactobacillus bifidus* var. Penn (1, 2). Chemically these factors belong in the group of N-containing polysaccharides (mucopolysaccharides) (3-5). In the past, antiviral effect has been ascribed to various mucoproteins and polysaccharides (6). The protective effect of different fractions of human milk against several neurotropic viruses has also been reported (7). Such observations made it desirable to investigate the possible inhibitory effect of fractions of human milk obtained in the course of the purification of the growth factors for *L. bifidus* var. Penn on virus multiplication.

**Preparation of Human Milk Fractions (HMF).** The fractions were obtained from 5 different pools of human milk. The pools were skimmed, deproteinized with  $ZnSO_4$  and  $Ba(OH)_2$  and desalted by means of ion exchange. Subsequently, the materials were adsorbed onto charcoal, washed repeatedly with water, dilute acetic acid, and finally eluted (6 times) with 20% acetic acid and 5% phenol. The details of the procedure have been described elsewhere (5). The 6 eluates derived from each of the 5 pools of human milk were lyophilized separately and the dried materials, in appropriate amounts, were dissolved in buffered saline solution for use in the experiments. The pH was adjusted to 7.0-7.2. On testing, only the 3rd, 4th, and 5th eluate showed some degree of inhibition of viral multiplication. Since heating of the HMF solutions to 120° C for 15 min did not destroy the activity, the materials were autoclaved before testing. Up to 30 times the active amount per embryo showed no toxic effect on chick embryos.

The PR8 strain of influenza A and the Enders strain of mumps virus were employed in the experiments. None of the HMF's, in amounts up to 200 mg/ml, inhibited the agglutination of chicken erythrocytes by 4 units of heated influenza A or mumps viruses.

**Effect on Virus *in vitro*.** To a solution of HMF (50 mg/ml) was added an equal amount of a 1:10 dilution of active PR8 or mumps virus. Mixtures of equal amounts of saline solution and the virus dilution served as control samples. The mixtures were incubated at temperatures ranging from 4° to 37° C for periods from 2 to 18 hr. After the incubation periods, the infectivity titers for chicken embryos were determined. No significant differences were found between the infectivity titers of the virus samples treated with HMF and the controls.

<sup>1</sup> Supported by a grant of Wyeth Laboratories, Philadelphia.

**Effect of Active Influenza Virus and RDE on HMF.** HMF solutions (50 mg/ml) were incubated *in vitro* for 18 hr at 37° C with an equal volume of a preparation of active influenza virus containing  $10^3$  hemagglutinating units/ml or with the receptor-destroying enzyme (RDE) added to a final concentration of 10% (100 units/ml). At the end of the incubation period, the mixtures were heated at 120° C for 15 min. The treatment of the HMF solution with the virus or the RDE did not diminish the inhibitory effect on the propagation of the influenza and the mumps viruses as tested *in vivo*.

**Inhibition of Multiplication of Influenza and Mumps Viruses.** Influenza: 11-day-old chick embryos were used. The HMF solutions were injected by the allantoic route, followed immediately by a challenging dose of 100 ID<sub>50</sub> of the influenza virus. An aliquot of the allantoic fluid from each embryo was removed after 24 hr and the samples were pooled. After 48 hr the remainder of the fluids was harvested from each egg and also pooled. In control series, saline solution was substituted for the HMF solutions. The degree of viral propagation was determined by titration of the hemagglutinin in the allantoic fluid pools with 1% chicken erythrocytes employing the pattern test. In several experiments, the infectivity titer of the pools for chicken embryos was also determined.

The HMF's showed considerable difference in their ability to inhibit the multiplication of influenza virus. The range was from 10 to 40 mg in 0.5 ml of saline solution/chick embryo. These amounts inoculated immediately before the challenging dose inhibited the multiplication to the extent that no hemagglutinin was detectable after 24 or 48 hr in the allantoic fluids of the treated eggs. Infectivity titrations in chick embryos of the allantoic fluids collected after 48 hr from the treated eggs showed usually less than 1% of the virus present in the controls. The infectivity titrations were performed in 10-fold steps using 5 eggs for each dilution of the pools.

Inoculation of the HMF solutions up to 24 hr before the virus gave identical results, but when the material was injected 2 hr after the virus, the inhibi-

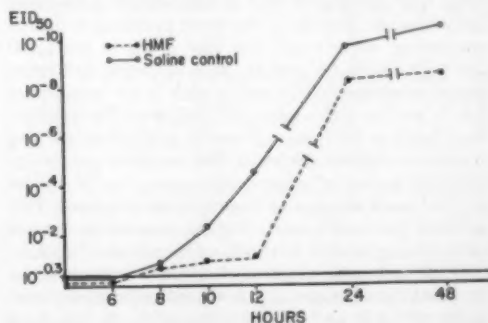


FIG. 1. Influenza virus A (PR8) growth curve in chick embryos in the presence of HMF (0-48 hr) infectivity titration of the allantoic fluids.

tory effect was diminished considerably. No hemagglutinin was detectable in the 24-hr harvest but after 48 hr the virus titers were similar to those of the controls. The effect was also less pronounced when the challenge dose of virus was increased to 10,000 EID<sub>50</sub> and injected immediately after the HMF solution.

The influence of the HMF on the 48-hr growth curve of the PR8 virus is shown in Fig. 1. In this experiment, one series of 40 embryos was inoculated with a solution of 20 mg of HMF in 0.5 ml of saline by the allantoic route, and a 2nd series of 40 embryos with 0.5 ml of saline by the same route. Immediately thereafter both series were challenged intra-allantoically with 100 EID<sub>50</sub> of PR8 virus. The allantoic fluids of groups of 5 eggs from each series were harvested at the indicated time intervals and pooled, and the infectivity titers for chick embryos of the pools were determined. In this experiment, HMF of low potency had to be used because none of the more potent fractions were available in the quantity needed for growth curves, yet significant differences in the treated and control series could be demonstrated up to the 48th hr of incubation (Fig. 1).

*Mumps:* Eight-day-old chick embryos were injected

with 20 mg of HMF in 0.5 ml of saline solution intra-allantoically and subsequently infected with 10,000 EID<sub>50</sub> of mumps virus by the same route. The allantoic fluids were harvested after 6 days and pooled. Viral hemagglutinin could not be demonstrated in the pools. The infectivity titrations of the 6-day pools of allantoic fluid showed 0.01% of the virus present in the control samples.

The inhibitor for influenza and mumps virus multiplication found in human breast milk is not identical with the mucoprotein inhibitor of hemagglutination since (a) the HMF does not inhibit hemagglutination; (b) its inhibitory effect is not destroyed by RDE or by incubation with active virus; and (c) the HMF's have been deproteinized.

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Manuscript received November 20, 1952.

## Comments and Communications

### 2,4-D Herbicides Pose Threat to Cotton and Other Susceptible Crops

QUITE reminiscent of the cattle-sheep wars of the Old West is the present controversy between the cotton growers and rice growers in the South. The focal point of this argument is the vast fertile area known as The Delta in the state of Mississippi. However, the controversy is going on in many other areas, wherever 2,4-D herbicides are being used near susceptible crops such as cotton, grapes, beans, and several others.

The problem has become acute in the Mississippi Delta because of the recent introduction of rice as a crop. The growing of rice in this section is economically feasible. But one of the great problems is that of controlling coffee-weed, and this is where the 2,4-D herbicide enters the picture. Rice, of course, is a member of the grass family and as such is not sensitive to 2,4-D, but the coffee-weed is killed by it. The result is that 2,4-D in its various forms is sprayed on the rice paddies to control this weed. The herbicide can be applied by means of ground equipment, but it can be applied much cheaper as a spray from airplanes. This is where the trouble starts that has resulted in damage suits totaling several hundreds of thousands of dollars.

What makes the problem of scientific interest is the fact that cotton, especially, is almost fantastically sensitive to 2,4-D and related compounds. It has been stated facetiously that if one walks through a field of cotton with a label from a 2,4-D container in one's pocket the cotton will be damaged. Yet it is possible

that if 2,4-D had been spilled on the label some damage to nearby cotton might occur.

To illustrate a similar condition, a case may be cited that occurred several years ago. On one large plantation a dry spray rig was driven down a plantation road between fields of cotton. This spray rig had not been used to spray 2,4-D since the year before. The amazing fact is that moderate but typical 2,4-D damage showed up on one side of this road for several hundred feet. Presumably this was on the side toward which the wind was blowing at the time the equipment was moved.

The above is an extreme case, to be sure, but many other instances could be cited almost as spectacular. During the summer of 1953 typical 2,4-D damage to cotton appeared along several highways in a number of southern states. As nearly as can be ascertained, this was caused by leaking containers of the herbicide that were being hauled along highways in trucks.

Most of the damage to susceptible crops appears to result from spray application either from the ground or from the air. The use of dusts containing 2,4-D or other hormone-type herbicides was outlawed by the Civil Aeronautics Authority several years ago because of the extreme hazard from drift. The spraying of 2,4-D from airplanes has often resulted in great loss. In one instance 4000 acres of vineyards were damaged by drift from air application of herbicide over grain fields 4-15 miles away. Case after case might be quoted where cotton was damaged both from the ground and from aerial application. It is not at all unusual for



severe damage to occur 4 or 5 miles away from the site of ground applications. There have also been cases where insecticides have been contaminated with minute amounts of 2,4-D. In one such case an insecticide manufacturer paid damages of \$50,000 to a large cotton plantation owner for such alleged damage.

In many cases the manner by which the herbicide drifted onto the susceptible crop is almost inexplicable. There have been cases where severe damage occurred to cotton that was up-wind from the site of 2,4-D application. The only explanation is that later air currents picked up the herbicide and transported it. Another rather amazing case occurred in the South during 1953. Cotton was damaged by 2,4-D that was applied before the cotton was planted. What appears to have happened is that the herbicide was applied to control willows. The season was dry, and the chemical collected in the dust and soil. Later, winds picked up the contaminated dust and carried it for many miles to damage cotton.

In order to determine just how much 2,4-D is required to cause damage to cotton, the Mississippi Agricultural Experiment Station ran some tests last year. It was found that less than  $\frac{1}{2}$  g/acre was sufficient to cause deformation of the leaves of seedling cotton. This is an infinitesimal amount when it is considered that it is spread over an acre. Some types of 2,4-D are much more volatile than others, but the fact remains that any of them may be carried by air currents for considerable distances and that after leaving the spray nozzle they are no longer under human control.

The result of all of this is that various states have passed regulations in an attempt to reduce the damage caused by 2,4-D, 2,4,5-T, and related hormone-type herbicides. Some states even require that all sales of these compounds be recorded as in the case of narcotics. Texas requires that a \$20,000 surety bond be posted before permission may be obtained to apply 2,4-D. Other regulations specify minimum distances from susceptible crops.

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Received November 2, 1953.

## Malignant Tumors and High Polymers

A possible explanation of "Malignant Tumors Resulting from Embedded Plastics in Rodents" (1) is that many high polymeric materials contain free radical groups as the result of residual initiator, enclosure of growing chains, or pyrolysis or peroxidation of polymer or plasticizer during calendaring or molding. In the case of cellophane, radical-forming groups are introduced in the xanthane stage. By transfer of unpaired electrons to (or capture from) molecules in surrounding tissues, free radical chain reactions would be started identical to those initiated, for example, by x-radiation or radioactivity. Many, if not all, carcinogens are compounds capable of forming free radicals (2).

If such be the case, the following predictions may be made as to the relative carcinogenicity of polymers and should serve as a basis for testing this hypothesis.

a. The most actively carcinogenic resins should include proliferous ("popcorn") polymer (3), because of its extraordinary reactivity, and products of negative free radical initiation by metallic sodium (4), hydroquinone and diazoamino-benzene (5), or other reducing agents, because of the reduced probability of termination by initiator or growing chain radicals of like charge.

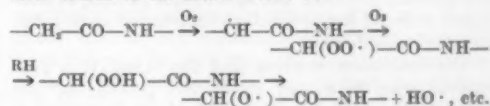
b. The usual peroxide-initiated addition polymers should possess the same order of magnitude of carcinogenicity regardless of their functional groups or chemical reactivity.

c. Polyvinyl alcohol (6) and acetals (7) might be expected to contain fewer free radicals than polyvinyl acetate because of the alcoholysis and acetalization steps in their preparation.

d. Ionic polymerization, initiated, for example, by aluminum chloride (8), should give resins of low carcinogenicity, as should condensation polymerization of polyesters and polyamides.

It must be pointed out that oxidation and pyrolysis during high-temperature processing could alter the content of polymeric free radicals. Preferably, films for the proposed experiments should be cast from solution in solvents other than ketones or ethers.

It might be questioned whether Dr. Oppenheimer's two principal limitations on the free-radical hypothesis, the problem of transport and carcinogenesis by condensation polymers, might not be explained by chain transfer reactions within the body and by peroxidation at secondary or tertiary carbons during processing, respectively. In the case of nylon, a possible course of the latter would be:



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Received September 16, 1953.

REFERRING to the comment by Andrew F. Fitzhugh dated September 16, 1953, we would like to submit the following: The appearance of tumors of malignant character adjacent to or surrounding embedded synthetic high polymers would seem to indicate the diffusion of carcinogenic agents into neighboring cells,

or the removal of tumor inhibitors by adsorption to the plastic. Thinking along these lines, the possibility presents itself that free radicals or free radical-yielding substances are involved. This is particularly pertinent in view of the prevailing polymerization techniques using radical-delivering catalysts, and in view of the existence of free radical mechanisms in the living cell, as pointed out by Waters (1) and others. In this respect we are in full agreement with the views of Col. Fitzhugh; in fact we have initiated and carried out for more than a year an experimental program to test this possibility. The program includes the use of polymers of different degrees of radical or peroxide contamination, and of different tendencies as carriers of long-lived radicals (as shown by their ability to continue to polymerize). We are also using the radioactive tracer technique to follow the path of sources of potential radicals leaving the polymer.

Because of the slow character of the work no conclusive results are as yet available. It does not, however, appear that Col. Fitzhugh's and our own expectations are borne out, since apparently there is no correlation between the carcinogenic effectiveness of synthetic polymers and their tendency to include, carry, or release free radicals. There is, for instance, an appreciable carcinogenic activity with condensation polymers.

The real difficulty in our investigation, not touched upon by Col. Fitzhugh, lies in the problem of transport. If a radical were to cover the distance, substantial in terms of molecular dimensions, from polymer to the site of the cancer, it would be extremely unlikely to survive. Similarly, a chain process, whereby unpaired electrons would be transferred, is difficult to conceive in view of the large number of steps and components involved. The agent must further be conceived to be of low molecular character so as to penetrate cell membranes.

The conclusion remains that the agent, if a free radical, must be a very stable one, possibly an ion radical, or a molecule that is liable to turn into a radical or participate in radical reactions once it reaches the interior of the cell. The agent might be derived from monomer, catalyst, or catalyst derivatives, products of oxidation or interaction with the bathing lymph fluid. The best clue as yet lies in the observation, so far uncontradicted, that only synthetic high polymers seem to be carcinogenic. This limits explanations based on free radical theories to addition polymers. The carcinogenicity of synthetic condensation

polymers would demand a different mechanism and might possibly be attributable to an intrinsic activity of some monomeric constituents or their derivatives.

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Received October 2, 1953.

### Fashions in Medicine and Science

H. J. Morowitz (1) has illustrated fashion in science by an elegant and impressive method; the number of papers published per year (about the biological effects of radiation) was shown to follow a rapid rise and then an almost exponential decay as a function of time.

Penrose (2) a while ago made use of the same method to illustrate fashion in medical therapy. His example dealt with the use of thallium in the treatment of skin diseases.

It is interesting to observe some of the differences between these two mental epidemics. A longer lag time previous to the rapid rise in the number of papers as well as a longer decay period seem to be characteristics of fashion in medical therapy; further features of the latter are the favorable description of the results obtained during the rapid rise period and a preponderance of critical papers coinciding with the slow decline or period of "increasing immunity to the idea of the treatment."

Speculations about the factors contributing to the above observed differences are left to the reader.

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Received October 9, 1953.



## Book Reviews

**Histochemistry: Theoretical and Applied.** A. G. Everson Pearse. Boston: Little, Brown; London: Churchill, 1953. 530 pp. Illus. + plates. \$12.00.

This book purports to deal with the theoretical and practical aspects of microscopical histochemistry. The first part comprises a number of chapters which treat the rationale of the methods discussed. Brief chapters on the history of histochemistry and on fixation are followed by three sections of almost equal size: amino acids and proteins, carbohydrates, lipids, aldehydes and ketones, and enzymes. These are followed by a rather large chapter on pigments and by two very small ones on inorganic constituents and physical methods. The second part of the book, the Appendix, contains simplified instructions for certain recommended methods.

As compared with Glick's book, the treatment of the subjects selected is far more comprehensive and detailed. As compared with Gomori's book, a broader treatment of nonenzymic proteins and other organic substances will be found. Especially emphasized are the methods proposed by Danielli and some derivatives of these methods. Inorganic components are all but neglected.

In a subject as fluid as histochemistry it is advantageous to consult several textbooks with diverse viewpoints, each with its own special emphasis, depending on the experience of the author. This situation is particularly useful for workers in other fields who are seeking some general or specific histochemical method or modification. Particularly helpful for such workers are the more recent references which have appeared since Gomori's book.

In general, the better-known textbooks on technique for histologists or pathologists have been written by workers with an extensive experience in broad biological problems, in the course of which they have used or developed many techniques. This book is an exception, as the author's experience seems to have been confined to a limited number of rather specialized problems. The result is a certain superficiality and immaturity in judgment which I find difficult to recommend. Here are a few examples: A certain method is recommended because it is easy and consistently yields a visible, stable end product. It would seem that the most important factor, scientific reliability, was omitted. The history of histochemistry is replete with the development of methods which are easy, etc., but unfortunately unreliable. In these instances, the use of such methods has led to incorrect and misleading conclusions. The author repeatedly recommends some method for routine work—surely methods which are not suitable for routine work (presumably by a technician) deserve serious consideration because they may lead to concepts more important for the morphologist than many a technical trick. Moreover, it has happened in the past that a method requiring unusual

skills or equipment may become routine at a later date.

Quantitative data in support of some morphological procedures are sometimes given, but not frequently or extensively enough. The almost complete divorce of methods from concepts derived through their application constitutes an evasion of a functional relationship which I believe to be a *sine qua non* of a satisfactory book on histochemistry. Despite the general adherence to sound chemistry, the distinction between this and tinctorial cookery is sometimes vague, or even nonexistent, as in some parts of the sections dealing with pigments and the scleroproteins. There are, in addition, far too many instances of specious organization of findings as tables or diagrams, where none is justified by present evidence. And finally, whether for lack of space or otherwise, some summary statements are made categorically, and possibly erroneously, as for example on the functions of phosphatases.

I could not share the author's exaggerated enthusiasm in certain sections ("It was by a stroke of genius . . ."), nor did I find pleasing his reliance on technical jargon. Some sentences were poorly constructed and even unintelligible. The author and subject index are detailed and useful.

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**Measurement Techniques in Mechanical Engineering.** R. J. Sweeney. New York: Wiley; London: Chapman & Hall, 1953. 309 pp. Illus. \$5.50.

This book concentrates on the measurement of mechanical, thermal, electrical, and chemical variables commonly used in the performance testing of fuels, prime movers, and associated power station equipment. Scant attention is given the manufacturing processes usually supervised by the mechanical engineer, and none at all to stress analysis, materials testing, and vibration. It is not a laboratory manual but a reference book which might well be kept at hand for undergraduate laboratory courses. The construction of standard instruments is described or shown schematically, theory needed for their design and operation is set forth, basic standards are described together with suitable methods of calibration, and the pitfalls likely to be encountered in routine use are pointed out.

An opening chapter discusses readability, sensitivity, hysteresis, installation and ambient effects, speed and stability, and dispersion. There are brief chapters on mensuration, mass, time and speed, dynamometers, calorimetry, automatic controls, and the analysis of coal, water, and combustion products. More extended treatment is given to meters for electrical measurands, and to pressure gages. Fluid flow and temperature receive most attention.

For the most part, the factual material seems sound, and the author manages to achieve a presentation suitable for either the undergraduate or the practitioner

new to the field. The description of basic standards is unusually complete. However, one notes a confusion between slack and elastic diaphragm gages, an explanation of critical flow which omits showing a nozzle cross section, a misleading schematic for simple proportional control, the use of "power" to mean stiffness, and the use of  $\psi$  for lb per sq in. There is to me an imbalance between the partial differential equation on page 2 and the large sectional drawing of globe valves which constitutes page 277. The chapter on automatic control is quite inadequate. Throughout the book there is a general tendency to expound design formulas for commercially available instruments which no engineer would think of building for himself.

A preponderance of short one-clause sentences gives a style which is understandable yet not pedestrian. The author's logic is not always clear, however, as when he introduces driving dynamometers by saying "Absorption dynamometers are useful only in testing engines." References are to be found as footnotes on the page concerned, which is convenient. Type is very readable, and few errata were found.

H. L. MASON

Office of Basic Instrumentation

National Bureau of Standards, Washington, D. C.

**Toxicity of Industrial Organic Solvents.** Rev. ed. Medical Research Council, Industrial Health Research Board, Report No. 80. (Revised in consultation with the Toxicology Committee). Ethel Brown-ing. London: H.M. Stationery Office, 1953. 411 pp. £1.

This book is a revision of Report No. 80 issued in 1937 by the Medical Research Council of the Industrial Health Research Board, London. This new edition does not attempt a critical review of available information; however, it is an excellent source of information with extensive references up to 1948. Even though the book is now several years out of date, it is a valuable reference for medical officers and those charged with safeguarding the health of individuals engaged in the manufacture, use, and handling of the common organic solvents.

The subject matter is divided into 10 chapters, each dealing with from four to thirty common, industrially important organic compounds. The classes of compounds covered are hydrocarbons, chlorinated hydrocarbons, alcohols, ethers, esters, ketones, glycols and derivatives, amines and coal tar derivatives, nitro compounds, and six miscellaneous compounds.

Each compound is treated differently because of the available information. In general, the toxic effects in animals and in man are treated separately. Such important items as absorption, excretion, symptoms, toxicity, acute and chronic poisoning, lethal and narcotic concentrations, and effect on metabolism are reviewed. In addition, industrial problems such as dangerous concentrations, methods of measuring concentration, treatment and post-mortem findings (of little concern to the average individual) are given consideration.

Such items as properties, commercial preparation, and uses add little to a book of this nature.

This book is especially recommended as a reference book for those concerned with the health of workers exposed to common industrial solvents.

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## Books Reviewed in THE SCIENTIFIC MONTHLY

### November

**The New Force.** Ralph E. Lapp. New York: Harper, 1953. x + 238 pp. \$3.00.

Reviewed by Bowen C. Dees.

**Teamwork in Research.** George P. Bush and Lowell H. Hattery, Eds. Washington, D. C.: American Univ. Press, 1953. xii + 191 pp. \$4.00.

Reviewed by Eric A. Walker.

**The Road to Abundance.** Jacob Rosin and Max Eastman. New York: McGraw-Hill, 1953. vii + 166 pp. \$3.50.

Reviewed by Hubert N. Alyea.

**Digging Beyond the Tigris.** Linda Braidwood. New York: Schuman, 1953. xii + 297 pp. Illus. + plates. \$4.50.

Reviewed by Samuel Noah Kramer.

**Cacti and Succulents.** G. Gilbert Green. London-New York: Pitman, 1953. 238 pp. Illus. \$7.00.

Reviewed by Edward J. Alexander.

**Calculus.** C. R. Wylie, Jr. New York: McGraw-Hill, 1953. x + 565 pp. Illus. \$6.00.

Reviewed by F. A. Ficken.

**Stewart's Scientific Dictionary**, 4th ed. of *National Paint Dictionary*. Jeffrey R. Stewart. Alexandria, Va.: Stewart Research Laboratory, 1953. 788 pp. \$10.50.

Reviewed by B. G.

**High Jungles and Low.** Archie Carr. Gainesville, Fla.: Univ. Florida Press, 1953. xvi + 266 pp. Illus. \$4.50.

Reviewed by Lorus J. Milne and Margery J. Milne.

**The Yields of a Crop.** W. Lawrence Balls. London: E. & F. N. Spon, 1953. xv + 144 pp. Illus. + plates + charts. 21s.

Reviewed by A. A. Moursi.

**Social Behaviour in Animals.** N. Tinbergen. New York: Wiley; London: Methuen, 1953. xi + 150 pp. Illus. \$2.50.

Reviewed by W. C. Allee.

**Outlines of Structural Geology**, 3rd ed. E. Sherbon Hills. New York: Wiley; London: Methuen, 1953. xi + 182 pp. Illus. + plates. \$3.00.

Reviewed by Arthur Bevan.



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- Jan. 11-13. Southern Weed Conference. Memphis, Tenn.
- Jan. 13. Astronomical Society of the Pacific (Annual). San Francisco, Calif.
- Jan. 13-14. American Pomological Society (Annual). Indianapolis, Ind.
- Jan. 13-15. American Society of Photogrammetry (Annual). Washington, D. C.
- Jan. 13-20. Australian and New Zealand Associations for the Advancement of Science. Canberra, Australia.
- Jan. 14. American Genetic Association (Annual Business). Washington, D. C.
- Jan. 18-23. Pakistan Science Congress (6th Annual). Karachi, Pakistan.
- Jan. 19-22. American Institute of Electrical Engineers (Winter general). New York, N. Y.
- Jan. 22. Public Health Workshop on Dental Care in Industry (2nd). New York, N. Y.
- Jan. 23-28. American Meteorological Society. New York, N. Y.
- Jan. 25-27. American Society of Heating and Ventilating Engineers (60th Annual). Houston, Tex.
- Jan. 25-27. Conference on High Energy Nuclear Physics (4th Annual). Rochester, N. Y.
- Jan. 25-29. Institute of the Aeronautical Sciences (Annual). New York, N. Y.
- Jan. 28. American Federation for Clinical Research (Annual). Portland, Ore.
- Jan. 28-30. American Physical Society. New York, N. Y.
- Jan. 28-30. American Association of Physics Teachers. New York, N. Y.
- Jan. 28-30. High-Speed Computer Conference. Baton Rouge, La.
- Jan. 29-30. American Geophysical Union. Los Angeles, Calif.
- Feb. 1-5. American Society for Testing Materials (Spring). Washington, D. C.
- Feb. 4-6. American Society for Quality Control, Textile Quality Control Conference (4th Annual). Raleigh, N. C.
- Feb. 4-6. Institute of Radio Engineers' Conference and Electronic Show. Tulsa, Okla.
- Feb. 8-9. Conference on Marine Corrosion Problems. Berkeley, Calif.
- Feb. 13-14. American Educational Research Association. Atlantic City, N. J.
- Feb. 14-16. National Society of College Teachers of Education. Atlantic City, N. J.
- Feb. 15-18. American Institute of Mining and Metallurgical Engineers. New York, N. Y.
- Feb. 15-18. Society of Economic Geologists. New York, N. Y.
- Feb. 21-25. Latin American Congress of Oto-Rhinology (3rd). Caracas, Venezuela.
- Feb. 25-27. The American Academy of Forensic Sciences. Chicago, Ill.
- Feb. 28-Mar. 4. Pan American Association of Oto-Rhinology and Broncho-Esophagology. Mexico City, Mexico.
- Mar. 4-5. American Society for Metals (Mid Winter). Boston, Mass.
- Mar. 8-10. American Institute of Chemical Engineers. Washington, D. C.
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*Prepared by*

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*Associate Professor of Anatomy, College of  
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**GERTRUDE KOPECH**

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Dillon and Murphy, *American Journal of Roentgenology  
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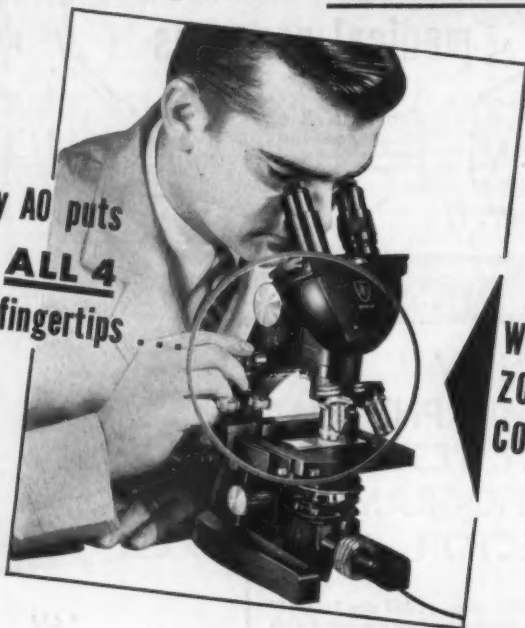
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